2014 SUPPLEMENTAL FOREWORD[1]

"....And as for rivers, I believe it is evident, that they are furnished by a superior circulation of Vapours drawn from the Sea by the heat of the Sun which by Calculation are abundantly sufficient for such a supply. For it is certain that nature never provides two distinct ways to produce the same effect, when one will serve. But the increase and decrease of Rivers, according to wet and dry Seasons of the year, do sufficiently show their Origination from a Superior circulation of Rains and Vapours"... (Keill 1698)[2].

Compare Keill's quotation from 316 years ago with my recollection of a comment in a newspaper by an Idaho legislator in the early 1970s: *"...If God can't guarantee a minimum instream flow, how do you expect us to?..."*

It appears as if human knowledge concerning streamflows had not increased much between 1698 and 1976 (278 years) if solely based on those quotations.

Positive change can be achieved with good science and public comprehension. During the 38 years that followed the 1976 conference, I have been fortunate to observe and participate in immense amounts of positive, productive and protective science based outcomes achieved by state, federal, tribal governmental and private partnerships.

Laws, regulations and programs recognizing instream flow and water level conservation benefits and actions have expanded. This positive momentum has been energized by increased public awareness, comprehension, and participation.

A focal group contributing to this advancement and maintaining its momentum has been the Instream Flow Council (IFC). IFC is composed of representatives from each of the state fish and wildlife agencies in the United States and its territories and the provincial and territorial fish and wildlife agencies of Canada. The seeds for this group were planted before and during the 1976 Boise meeting. An example of a cooperative seed was the fact that the Boise conference was jointly sponsored by the Power Division of the American Society of Civil Engineers and the Western Division of the American Fisheries Society.

Now, instream flow and water level analyses linked to natural hydrologic variability and processes are fundamental to any stream flow and lake/reservoir level project, research study, and water-planning program. Governmental and private sector watershed-planning and subsequent actions rely on scientifically sound instream flow and water level studies.

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[1] *Orsborn, J. F. and C. H. Allman. 1976. Editors. Proceedings of the Symposium and Specialty Conference on Instream Flow Needs: Solutions to technical, legal and social problems caused by increasing competition for limited streamflow. 2 Volumes. Presented by the Western Division of the American Fisheries Society and Power Division of the American Society of Civil Engineers at the Rodeway Inn-Boise, ID. May 3-6, 1976. Published by American Fisheries Society (AFS). Bethesda, MD. 2014* Supplemental Foreword to Instream Flow Council (IFC) e-reprint-with AFS permission.

[2] *Keill, John. 1698. An examination of Dr. Burnet's Theory of the earth together with some remarks on Mr. Winston's New theory of the earth. Printed at the Theater, Oxford, London. Page 148.*

I trust the e-reprint of this conference publication will contribute to those efforts. More people will be able to avail themselves of this historic reference thanks to the IFC and the American Fisheries Society (AFS).

Despite my positive outlook, some that review this publication for the first time may be surprised when agencies and members of the private sector still use the term "*minimum flow*". Others may wonder why some members of the public and agencies still fail to recognize or comprehend there are seasonal life-stage supporting minima. Others might question why there still isn't full consideration and integration of the variety of uses, requirements, and processes meriting recognition and attention beyond those specific to fish. I don't know all the answers. I can only hope this publication will benefit the discussion.

In 1975-6, "*minimum flow"* was considered to be the unused amount *of water* remaining in a water body, after all the impoundment, diversionary, and withdrawal demands (irrigation, municipal and industrial supply, hydropower, etc.) had been met. Certainly we have come farther than this in 38 years. I continue to hope so.

It is an honor to have been bestowed "*Lifetime IFC Membership"* and the 2013 IFC "*Making a Difference Award*". It is even more gratifying and extraordinary this e-reprint will be accessible to current and future generations. This IFC action will help preserve the history of water issues, uses, methods, and values related to instream flow and water level conservation.

It is my pleasure to provide this 2014 supplemental e-reprint foreword to the original 1976 two volume conference publication.

-John F. Orsborn, PE (retired) PhD - May 2014 (orsborn@olympus.net)

INSTREAM FLOW NEEDS

Volume I

American Fisheries Society

Volume I

PROCEEDINGS
of the
Symposium and Specialty Conference
on

INSTREAM FLOW NEEDS

Presented by the
Western Division of the
AMERICAN FISHERIES SOCIETY
and the
Power Division of the
AMERICAN SOCIETY OF CIVIL ENGINEERS

Solutions to technical, legal, and social problems caused by increasing competition for limited streamflow.

Rodeway Inn - Boise, Idaho
May 3-6, 1976

Published by
American Fisheries Society
5410 Grosvenor Lane
Bethesda, Maryland 20014

September 1976

FOREWORD

The original intent of this conference, as it was conceived in the early 1970's, was to provide a forum and a proceedings to serve as a focal point and a primary reference for persons working on water resource allocation problems. This intent has not changed, though the emphasis on program and proceedings content shifted. Originally the conference was to serve the technical needs of disciplines dealing with methodologies. These needs were thoroughly assessed by a cooperative study, workshop and report prepared by the U.S. Fish and Wildlife Service, Utah State University, and numerous reviewers. Recognizing this accomplishment, the Steering Committee for the Instream Flow Needs Conference revised the original program to emphasize the interdisciplinary aspects of current problems, namely communication and the awareness of legal, social, and technical aspects of preserving instream values and diversionary necessities in emerging areas of conflict.

The success of any conference is, of course, the result of the combined efforts of many people. But the expertise and motivation of the individual contributors is the essence of the endeavor, and their contributions are sincerely appreciated. Also recognized are the cooperation and financial assistance of the following: U.S. Fish and Wildlife Service; U.S. Forest Service; Water Resources Council; Federal Energy Administration; Sport Fishing Institute; Trout Unlimited; State of Washington Water Research Center; and the Albrook Hydraulics Laboratory, Washington State University, where the proceedings was edited. The broad sponsorship reflects the multidisciplinary character of the program and the proceedings.

Papers are arranged in the chronological order of presentation at the conference. Each author prepared his paper camera ready for printing. The papers were reviewed by the editors who assisted with minor corrections or adjustments, but the language of the authors was retained.

We hope that the users of these proceedings will find them to be a valuable reference for instream flow problems.

EDITORS
John F. Orsborn
Charlena H. Allman

Albrook Hydraulics Laboratory
Washington State University
Pullman, Washington 99163
September, 1976

INSTREAM FLOW NEEDS SYMPOSIUM AND SPECIALTY CONFERENCE

Steering Committee

STEERING COMMITTEE CHAIRMAN
Fred Eiserman, Coordinator
Fisheries Management
Wyoming Game and Fish Department
Casper, Wyoming 82601

Race D. Davies*
Research Associate
Water Research Center
Washington State University
Pullman, Washington 99163

Harvey R. Doerksen*
Western Water Allocation
Research Manager
Western Energy and Land Use Team
U.S. Fish and Wildlife Service
Fort Collins, Colorado 80521

Jack C. Fraser
Regional Manager, Region 3
California Department of Fish and Game
Yountville, California 94559

Ronald W. Goede
President, Western Division
American Fisheries Society
Utah Division of Wildlife Resources
Logan, Utah 84112

Noel Larson,* Hydrologist
Watershed and Minerals Area Management
USDA Forest Service
Arlington, Virginia 22209

PROGRAM COMMITTEE CHAIRMAN
John F. (Jack) Orsborn, Professor and
Chairman, Dept. of Civil & Environmental
Engineering, Washington State University
Pullman, Washington 99163
(Member of Power Division Executive Comm.,
American Society of Civil Engineers)

FINANCE COMMITTEE CHAIRMAN
John C. Peters
Environmental Specialist
U.S. Bureau of Reclamation
Denver, Colorado 80225

LOCAL ARRANGEMENTS COMMITTEE CHAIRMAN
William S. Platts
Aquatic Biologist, Surface
Environment and Mining Program
U.S. Forest Service
Boise, Idaho 83706

Charles G. Prewitt*
Biological Aid
Western Energy and Land Use Team
U.S. Fish and Wildlife Service
Fort Collins, Colorado 80521

Frank R. Richardson
Acting Deputy Regional Director
U.S. Fish and Wildlife Service
Denver, Colorado 80225

Clair B. Stalnaker*
Fishery Research Specialist
U.S. Fish and Wildlife Service
Denver, Colorado 80225

Ken Thompson*
Aquatic Biologist
Oregon Department of Fish and Wildlife
Portland, Oregon 97208

Frank J. Trelease
Professor of Law
University of Wyoming
Laramie, Wyoming 82071

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*Program Committee Members

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INTRODUCTORY REMARKS

by Fred Eiserman

On behalf of the Power Division of the American Society of Civil Engineers and the Western Division of the American Fisheries Society, it is my privilege and pleasure to welcome you to Boise and to this Symposium and Specialty Conference on Instream Flow Needs. I sincerely hope that each and everyone of you will have an enjoyable and rewarding experience participating in these deliberations. In this bicentennial year, while it is appropriate to celebrate the accomplishments of the past, it is even more appropriate for citizens of this country to meet and deliberate the future; to set guidelines for those who will be the custodians and users of our natural resources in years to come. This, perhaps, will be the most important accomplishment of this symposium.

On July 12, 1976, it will be three years since the annual meeting of the Western Division of the American Fisheries Society was held in Salt Lake City and at which time preliminary discussions led to the following rather terse notation in the minutes. "While the votes were being counted, Fred Eiserman led a discussion on the desirability of dialogue between agencies and professions engaged in research, development, and the management of waters to obtain optimum flows for fish." He made a motion as follows: "The next president should establish a committee to develop a workshop or symposium on acceptable flows for trout in control streams." Motion seconded, motion carried.

From this rather modest beginning, it became rapidly apparent that the task was not to be consummated within the year and perhaps not at all. At the Western Division of the American Fisheries Society meeting held in Albuquerque in 1974, I reported back that although responses from inquiries to fisheries leaders in the western states were reassuring, the timing of a workshop or symposium for 1975 might not be appropriate. In fact, because of recent and forthcoming workshop on this subject, it was decided to shoot for a 1976 date. In addition, the workshop proposal was changed to a firm commitment for a symposium with a theme that would encompass the entire spectrum of activities associated with water resource planning, and that would generate a document which would provide information that could be used by water resource managers in providing for stream flows to protect natural environments. With that mandate, extensive preparations for a comprehensive symposium began. It was my good fortune that within the same time framework of the Western Division of the American

Fisheries Society deliberations on this subject Harvey Doerksen, John Orsborn, David Deane, and Burton Lamb of Washington State University were conducting a series of workshops that eventually led to a number of publications on the subject of regional instream flow needs in the Pacific Northwest. In 1972, the Pacific Northwest River Basins Commission and the Washington State Department of Ecology sponsored instream flow methodology workshops which assisted in the development of this symposium. More recently a workshop was held in Logan, Utah and sponsored by the U.S. Fish and Wildlife Service, Office of Biological Sciences, on methodologies for the determination of stream resource flow requirements. With expertise available from these activities, the Conference Steering Committee was developed. With the assistance of my good friend, John Peters, a meeting was arranged that eventually led to my introduction to John Orsborn and to his assuming the leadership role in the development of this conference. Because of his affiliations with the Power Division of the American Society of Civil Engineers, this group agreed to cosponsor this Symposium and Specialty Conference with the Western Division of the American Fisheries Society.

From these beginnings, I was to have the pleasure of associations with many professionals in water resource management and the very rewarding and satisfying experience of working with a distinguished group of individuals who served on this Symposium Steering Committee. I am very much indebted to these people for their labors in developing the program in which we are about to engage.

The lead role in obtaining financial assistance for this conference was handled by John Peters. As a result of his efforts, and those of a number of other Steering Committee members, this conference is being partially supported by the following agencies and organizations:

U.S. Fish and Wildlife Service
U.S. Forest Service
U.S. Water Resources Council
Federal Energy Administration
Sport Fishing Institute
Washington State University
State of Washington Water Research Center
Trout Unlimited

The American Society of Civil Engineers and the American Fisheries Society are indebted to these groups for this assistance, without which this conference could not have become a reality.

There is little reason for me to review the circumstances which make this conference extremely important. It is sufficient to note that with the advent of efforts toward energy self-sufficiency, the problems of proper water distribution have been intensified from the survival to the crisis stage. The problems associated with water management have existed since the advent of the first white settler, but never have they reached the serious proportions. Throughout this western country the construction of water conservation works have not kept pace with needs. Now that we have hopefully developed an ecological conscience, we are presently torn between the alternative of preventing localized, ecological disaster by sacrificing some monetary gain and that of doing business as usual with the eventual destruction of not only the fishery resource but the entire aquatic system associated with water environments. We have talked and written water conservation for the last 60 years, and we have finally reached our moment of truth--will we respond with vision and insight of the interdependency of man and his environment or will we again narcotize ourselves into believing that somehow we will maintain aquatic life systems without addressing ourselves to the fact that total development will have to be modified in favor of environmental requirements.

I believe that this Symposium and Specialty Conference on Instream Flow Needs could provide the basis for achieving the objectives of realistic stream flow releases which are most effective in providing for the preservation of existing levels of fish, wildlife, and other aquatic organisms and will still allow for the continued development of this country's water resources. To that end this will be a working conference for the exposure and open discussion of fundamental, single and multidisciplinary problems associated with the allocation of stream flow among competing and noncompeting uses. A major objective will be the generation of a proceedings of significant value to technical, legal, and political practitioners dealing with instream flow need problems. The Proceedings will be published by the American Fisheries Society as soon as the final editing has been accomplished at Washington State University. The contents of the Proceedings will include the presentations of all speakers who submitted their texts, outlines of the short courses, and summaries of the topic discussions. A late summer publication date is anticipated.

The program has been arranged to offer conference attendees numerous opportunities for involvement in panel discussions, short courses, and roundtables. I hope that each of you will take every opportunity to participate in this conference. Your contributions will assure its success.

PERSPECTIVES ON INSTREAM FLOW NEEDS

Henry P. Caulfield, Jr.
Department of Political Science
Colorado State University
Fort Collins, CO 80523

ABSTRACT

The problem of meeting instream flow needs is discussed, first, in historical perspective. The fundamental long-term policy conflict between instream and offstream uses of water in the arid West is set forth in terms of conflicting basic legal doctrines. The traditional Conservation Movement, beginning at the turn of the last century, and its means of conflict resolution is developed. The Environmental Movement of the 1960's and since is analyzed in terms of its political motivations seeking initially environmental quality and then environmental security. Current institutional arrangements for multiple objective planning are briefly described, and the unsolved problem of finding effective coalitions to obtain action meeting needs, including instream flow needs, is noted. Lastly, the problem of meeting instream flow needs is discussed in terms of alternative futures to the year 2000 and beyond.

INTRODUCTION

The problems involved in satisfying instream flow needs in rivers and their tributaries are diverse and numerous, as is well indicated by the papers that follow in this volume. They reflect the approaches and concerns of many different academic disciplines and professions: legal analyses of pertinent state and federal law; precise explication of technical fishery and hydrologic issues relating instream flow needs to water and related land planning processes as a whole; institutional strategies for gaining recognition and action; the specific role of public involvement; reporting experiences in attempts to realize instream values in various contexts of dams, other structures, and diversion; and other specific subjects of current concern. Although the emphasis in the papers is reporting of knowledge within the general subject area from many points of view, the underlying reason for developing this comprehensive knowledge base is to assist public action furthering instream values.

The assigned topic of this paper, "Perspectives on Instream Flow Needs," is delightfully unconstrained and thus it lends itself to many different approaches in an endeavor to make a relevant contribution. The approach taken here is to discuss the problem of meeting instream flow needs: (1) in historical perspective; and (2) in a perspective of possible alternative futures.

To make successful current decisions in furtherance of a cause, one must be able to see objectively that cause in terms of both of these perspectives. Much more could be discussed than what follows; but, hopefully, this analysis will provide valid and useful general guides.[1]

HISTORICAL PERSPECTIVE ON THE INSTREAM-OFFSTREAM ISSUE

The Fundamental Policy Conflict

Instream and offstream needs for water have been in fundamental conflict for a long time. The paramount public right of navigation, an instream use, was early established as basic policy in each of the American Colonies to which the private riparian right to the use of water and related land must give way. The protection of anadromous fish in their traverse of rivers was related to navigation. The Supreme Court in Gibbons vs. Ogden (1824) affirmed that the Congress under the Commerce Clause of the Constitution possessed the power to regulate navigation. Navigable rivers were recognized as public highways. Before the advent of the railroad in 1828, navigation was the only means of bulk transport and the development of the navigable capacity of rivers and canals was thus recognized to be a key instrument in economic development from East to West. Wisconsin vs. Duluth (1877) confirmed the power of Congress to spend federal funds for internal waterway improvements directly through the Army Corps of Engineers.

"The right to divert the unappropriate waters of any natural stream to beneficial uses shall never be denied," a provision of the Constitution of Colorado when it became a State in 1876, established the legal base for heavy reliance upon irrigation, an offstream use, in its economic development. The arid West has generally followed suit.

These "instream" and "offstream" doctrines came into major conflict in consideration by the Congress of what came to be the Flood Control Act of 1944. This Act authorized the Pick-Sloan Plan for development of the ten-state Missouri River Basin for: navigation, hydroelectric power, flood control, and irrigation. The upshot of this conflict was the adoption of the O'Mahoney-Millikin Amendment, proposed by senators from Wyoming and Colorado, respectively. This amendment provided, in effect, that, whenever there had to be a choice between these doctrines, then the offstream uses, consumptive uses in the upper basin would be given priority over navigational needs in the lower Missouri River. The resolution of this issue enabled major offstream and instream water resource developments to occur that might not otherwise have been politically feasible then or since. Continued delay in the development of upper basin irrigation projects, particularly in South and North Dakota, however, may well have put off prospects for confrontation to the year 2000 or beyond.

The success thirty-two years ago of Senators O'Mahoney and Millikin, with the united support of the arid western states, indicates the political strength then of offstream, largely irrigation, water users. The west is no longer as united in support of offstream irrigation uses. But the defeat in the Idaho House of Representatives on May 9, 1976, of a minimum stream flow bill indicates that in that state the political clout of irrigators is far from dead. In a few other western states with major irrigation potentials and overall rural political orientation (particularly North Dakota, South Dakota and Nebraska), irrigators with the support of offstream municipal and industrial water interests prevent much, if any, legal inroad upon water allocation from conflicting instream uses. However, such political strength is no longer assured in Colorado and, probably, in most other western arid states.

The Traditional Conservation Movement and Conflict Resolution

The Conservation Movement that became prominent under the leadership of President Theodore Roosevelt and Gifford Pinchot after the turn of the last century developed a political ideology that became dominant in the establishment of specific policies until the 1960's regarding use of the nation's natural resources. This ideology broadly encompassed and endeavored to harness politically what can be identified as three major policy thrusts.[2]

The development thrust, it can be asserted, is manifest in Alexander Hamilton's Report on Manufactures, in the spirit of the frontier and the settlement of the West. Economic development has been equated often with "progress" in American society. The development thrust is clearly the strongest of the three.

The progressive thrust in American politics is based on the value of individualism. Economic development in American society is also seen largely as a manifestation of individualism. But the individualism of the progressive thrust carries with it the idea of egalitarianism: of Thomas Jefferson's vision of a nation of yoeman farmers as the foundation of democracy, the Homestead Act of 1862, the anti-trust laws and of the "160 acre rule" in support of the family farm in the Reclamation Act of 1902.

The conservation thrust for Gifford Pinchot and his many followers meant "sustained-yield" and "multiple-use" of natural resources. Sustained yield, a concept of the nation's emerging scientific elite, grew out of developments in scientific thought during the latter part of the 19th century.

The doctrine of the traditional Conservation Movement, as expressed by Gifford Pinchot and repeated since by many others, extended Bentham's doctrine of utilitarianism to "the greatest good, for the greatest number, for the longest time." This epigram can be interpreted as responsive to the values of all three policy thrusts. Another doctrinal statement often quoted was this: "Conservation is not the locking of resources; it is their development and wise use." Thus the Movement clearly aligned itself with development and against preservation of resources as parks. Forestry meant economic use of forests constrained only by sustained yield. Pinchot and his followers strongly favored large scale development of hydroelectric power, an instream use, because they foresaw the eventual running out of coal, oil and natural gas. Pinchot also was a "progressive" and sought strong regulation of private development of hydroelectric power under what came to be the Federal Power Act of 1920. He did not support federal public development of hydroelectric power as did Senator Norris and many other "progressives."

The Inland Waterways Report of 1907 first enunciated officially the concept of "comprehensive multiple purpose river basin planning and development." Multiple purposes then meant: navigation, irrigation, hydroelectric power and soon, flood control. Also in 1907, President Roosevelt called for a "broad, comprehensive scheme of development" of the Colorado River basin. In two volumes in 1916 and 1918, respectively, E. C. LaRue of the U.S. Geological Survey published such a comprehensive plan, setting the stage for subsequent developments. Of greater national significance was passage of Section 308 of the Flood Control Act of 1927 which authorized the Army Corps of Engineers to make comprehensive multiple purpose planning studies for all the major river basins of the United States. It was these studies, around which strong regional political support often coalesced, that led generally to the great river basin developments of the 1930's and thereafter. The multiple purpose dam in which joint-costs are shared, usually a more economic means of development for each purpose than a single-purpose dam, became a great resolver of conflict and an instrument of complementary regional resource development.

During this period when the development thrust was exceedingly strong, ways were found to accommodate most major economic interests that asserted themselves.

For example, what has come to be known as the Fish and Wildlife Coordination Act of 1934 provided for investigation of potential damage to fisheries from water resource development projects and for measures in mitigation of damage at the cost of the project. Accordingly, hundreds of millions of dollars have been spent by the federal government through construction and operation of fish ladders to provide sustained yield of the anadromous fish traversing the Columbia River alone. This reconciliation, incidently, involved three uses of the river, all instream: navigation, hydroelectric power, and fishing. The traditional Conservation Movement, in its ideology and in its practical efforts, would appear with hindsight to have maximized the centripetal political forces that could build majorities to obtain the actions sought. Its practical political decision-processes involved ideological adherence, bargaining leading to compromise and vote trading.

The Environmental Movement

The Environmental Movement, or the new conservation movement of the 1960's and since, included and built upon the doctrine of natural resource preservation or the National Park tradition, which Pinchot and his orthodox followers rejected. The first national park, Yellowstone National Park, was established in 1874. The Sierra Club, so politically prominent and successful in recent decades, was founded in 1892 by John Muir, the patron saint of resource preservation. The Sierra Club, however, was not always so politically successful in clashes with traditional conservationists. In the great Hetch-Hechy controversy over federal authorization of a dam to be built by San Francisco which would back water into Yosemite National Park, Pinchot and Muir engaged in a classic doctrinal debate before a Congressional committee. Muir lost, and the dam was authorized by the Raker Act of 1913. Preservationists generally lost such controversies until 1956.

The great public controversy over the proposed authorization of Echo Park dam within Dinosaur National Monument and its deletion from the Colorado River Storage Project Act of 1956 was the result of a major political effort by the Sierra Club. It gave warning of things that could come.

Vigorous, and not completely anonymous, leadership by James McBrown, Asst. Director of the Bureau of Sport Fisheries and Wildlife, with the support of Secretary of the Interior Seaton and strong backup from appropriate interest groups, obtained passage of the Fish and Wildlife Coordination Act of 1958. This act added to previous acts bearing this title and provided for consideration and inclusion of enhancement measures, in addition to measures for mitigation of damage for fish and wildlife, in federally developed and licensed water projects. Also during the 1950's scientific concern and controversy was brewing over the effect of pesticides upon fish and wildlife. Rachel Carson, another federal fish and wildlife civil servant but also author of the best seller, The Sea Around Us, began work documenting ecosystem damage from pesticides which was portrayed in her most influential book, Silent Spring, published in 1962.

Congressional establishment of the Outdoor Recreation Resources Review Commission in 1958 and its subsequent report of January, 1962, sparkplugged by the dedicated efforts of the late Joe Penfold, Conservation Director of the Izaak Walton League of America, established a substantial consensus among the initiated, both inside and outside of government, that laid a strong base for the actions that were to come. The unanimous report in 1961 of the Bipartisan Senate Select Committee on National Water Resources also laid a strong basis for action. Finally, Congressional success in the latter 1950's in overcoming opposition of the Executive Branch to an increased federal regulatory and financial role in water pollution control indicated new dimensions of political concern that could be tapped by strong, positive executive leadership.

Ideologically, and in terms of its practical proposals, the bulk of President Kennedy's Special Message to the Congress on Natural Resources of February 1961 was in the tradition of the Conservation Movement of Gifford Pinchot. Only in the last section on Recreation, did he call for action on items outside this tradition: establishment of Cape Cod, Padre Island and Point Reyes National Seashores, enactment of a wilderness protection bill, and expansion of fish and wildlife opportunities. In these connections, he instructed the Secretary of the Interior, in cooperation with the Secretary of Agriculture and others, to take the lead in development of a comprehensive federal recreation land program and a long range wildlife conservation program.

As a first initiative along these lines Secretary of the Interior Stewart Udall, within two weeks of taking office, told his staff of his goal to double the acreage under the jurisdiction of the National Park Service within eight years. He then set to work with staff formulating what came to be the Land and Water Conservation Fund Act of 1965.* As enacted, this Act has financially fueled not only great expansion of the National Park Service but also substantially increased public recreation lands of the Forest Service and state and local recreation agencies. Positive executive leadership was also undertaken

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*The author was Assistant Director and then Director, Resources Program Staff, Office of the Secretary, Department of the Interior, Feb., 1961, to April, 1966.

early to enact a politically viable wilderness bill. This effort was successful in 1964. Staff of the Bureau of Sport Fisheries and Wildlife were instructed early in the Kennedy Administration to formulate a program for protection of endangered species of wildlife. But this secretarial initiative reinforced by subsequent events only materialized legislatively in stages and years later. An Ecological Research and Survey Act was drafted in 1964; but this proposal was put aside in the drive to enact many other bills with good chances of success when support of the Ecological Society of America was not assured.

What came to be the Water Resources Planning Act of 1965 was proposed to the Congress in July, 1961. The Water Resources Research Act was enacted in 1964. Under Interior's leadership new executive policies, standards and procedures for planning of water and related land resources were developed. These guidelines, approved by President Kennedy on May 15, 1962, embodied for the first time the concept of multi-objective planning with the three objectives of development of resources, their preservation in particular instances as "open space, green space and wild areas of rivers," all to be consistent with the well-being of people. The preservation objective was made capable of realization by the Wild and Scenic Rivers Act of 1968 and related legislation. Among the major controversies that were settled in the Colorado Basin Project Act of 1968 was that with regard to Marble and Bridge Canyon dams, by their deletion in the interests of natural preservation.

With strong Executive Branch endorsement, the Water Quality Act of 1965 was enacted with overwhelming Congressional support along with other major legislation of the same genus, including the National Environmental Policy Act of 1969, during the balance of the decade.

On the ideological level of political discourse, major changes had occurred by 1965. President Johnson sent to the Congress a Special Message on Conservation and Restoration of Natural Beauty in February, 1965, calling for a "new conservation," for specific measures consistent with the concept of environmental quality, and for a White House Conference on Natural Beauty in May, 1965.

Increasingly, as the decade progressed, the word "environment" was used officially as a general referent to the object of concern, rather than "natural resources." Why? Because "resources" connotes an economic dimension. "Nature" and "natural," on the otherhand, could not encompass the Administration's interest in preservation of historic buildings, landscape architecture, control of highway billboards and screening of junkyards--all seen as means of enhancing environmental quality. The animus which largely guided development of this official ideology of Environmental Quality was concern for the aesthetic and the ethical in the tradition of Emerson, Thoreau and the 19th century Naturalist, with resource development concerns on the back burner. This motivation is evident in a book, The Quiet Crisis, 1963, by the most important contributor to this political development, Stewart Udall, during his eight years as Secretary of the Interior.

By 1969 the name of the game had so changed at the national level of politics that when President Nixon appointed a frontier-development Governor of Alaska, Walter Hickel, to be Secretary of the Interior, Hickel was almost crucified in confirmation hearings. A long-term fully-believable Republican environmentalist, Russell E. Train, had to be hurriedly recruited from his position as President of the Conservation Foundation to be Under-Secretary of the Interior. Clearly, by the end of the decade, the Environmental movement was politically very real.

For many people, however, the first Earth Day in April, 1970, marks the beginning of the Environmental Movement.[3] It appears to them to have begun on the university and college campuses with thousands of students responding to prophecies by academic scientists of "ecocatrostrophe." The prophecies were of famine due to overpopulation; of widespread poisoning or cancer from radioactive particles, pesticides, fungicides, mercury, lead, etc.; globally excessive production of carbon dioxide; progressive destruction of the ozone layer that envelopes and protects life on earth; and others. Statements were made of "only fifteen more years of human life on earth" unless corrective measures were quickly instituted. The Environmental Movement became one of the several popular protest movements of the time.

On a more general intellectual level, current civilization was seen as lacking understanding of, and ignoring, ecological truth. Ecology as science is far from new. George Perkins Marsh might be said to be the first American ecologist; he first published his Man and Nature in 1864. What was new in the early 1970's was a general conversion of ecology's scientific paradigm into a normative paradigm, a general intellectual base for political action.

Scientifically, the ability of natural systems to persist and perform their functions despite inevitable environmental change is said to be related to the complexity of such systems. The more species of plants, animals and microorganisms that have co-evolved to share the energy flowing through an ecosystem, the more stable it is likely to be. Thus decline in biological diversity is seen as a major source of instability of natural systems that support human life. Decline in diversity is believed to be rapidly occurring in fact over major parts of the earth due to the impact of modern civilization.[4]

Normatively, this decline is taken to be bad. Human survival and survival of other endangered species indefinitely into the future is a fundamental value to be strongly fostered politically. Preservation of extensive lightly exploited natural communities to serve as ecological buffers and reservoirs of diversity (not just national parks and wild areas for human re-creation and edification) is the strategic means, hopefully, for realization of this value.

Environmental Survival, ideologically and rhetorically embellished around this basic ecological theme, came to dominate motivation in the Environmental Movement of the 1970's. The aesthetic and ethical motivations of the 1960's were still present; but they were secondary, if not non-existent, for many new environmentalists.[3]

In proposing establishment of the Environmental Protection Agency and in other ways, President Nixon early responded to this new political dimension of the Environmental Movement. Nevertheless, passage of the Water Pollution Act Amendments of 1972--which strongly reflected normative ecological thought in its environmental enhancement objectives, standards, and investment implications--had to be passed by the Congress over his veto. In his message to the Congress on Natural Resources and the Environment of February, 1973, he spoke defensively of the Nation being "well on the way to winning the war against environmental degradation--well on the way to making peace with nature." More significantly, the bulk of the message covered many useful and specific proposals to the Congress in the interests of environmental survival or security. In the next to the last paragraph though, Nixon said that "one of the highest priorities of my Administration in the coming year will be concern for energy supplies." This concern for running out, like that of the traditional Conservation Movement, was for sustaining economic development as well as military security. The political and administrative problems of energy vs. the environment have been with us since.

Today, as regards water and related land resource planning, the Environmental Movement, motivated both by desires for environmental quality and survival, works within the institutional arrangements authorized by the Water Resources Planning Act of 1965, as amended. Through principles and standards for planning established by the Water Resources Council and through Federal-State river basin commissions and other means created to coordinate and carry out planning, both instream and offstream water uses are considered. All types of water interests and related intellectual disciplines are involved in the processes of both the Council, the Commissions, and related agencies. As a result of this more balanced approach to planning than in the past, the recent Snake River Basin Plan prepared under the aegis of the Pacific Northwest River Basin Commission, for example, recommends: allocation of available water to future use for irrigation, municipal and industrial water, thermal power and instream flow uses, authorization of appropriation of water for instream flow purposes, and authorization of "natural and recreational river systems and for local greenway and greenbelt programs.[5]

The two objectives for plan formulation set forth in the Principles and Standards of the Water Resources Council that displaced those established in 1962, noted above, are: 1) National Economic Development, and 2) Environmental Quality.[6] Both objectives are to be equally considered; neither objective has been established as the superior of the other. The distribution of value among possible planning elements inspired by these objectives and included in a comprehensive plan is to be unique to the locale and time of the plan, except to the extent Federal or State regulatory acts (e.g. the Federal Water Pollution Control Act) has previously determined the result. This means that those motivated by the Environmental Movement in the planning of water and related land resources must seek their ends, professionally and politically, in <u>each</u> planning exercise, or they must successively stack the deck through previous regulatory legislation. Many people who may have believed that this latter was being done by the National Environmental Policy Act are now learning otherwise.

Preservation of opportunities for sport and commercial fisheries is by now a relatively old instream end to be sought and sometimes achieved in planning and subsequent action. Representation in the planning process of those concerned specifically with preservation of non-games species, together with those motivated by very broad ecological objectives, is legitimate in the planning process as now officially established. This enlargement of representation beyond that of "fish and game" has caused problems for the more traditional fish and wildlife biologists, but these problems are not nearly so traumatic as those experienced by most civil engineers and many economists!

Whether the present professional/political institutional system of planning water and related land resources basin by basin, within a context of multi-interest public participation, can overcome evident centrifugal political forces and can find on a regular basis coalitions of effective political support for action appears doubtful unless substantial institutional changes are made.[7]

Also, to overcome frustration and waste in planning and efforts to obtain action, it would appear essential that a basic choice, backed by an effective national consensus, be made between National Economic Development as the primary official objective with Environmental Quality secondary, or vice versa. Whichever objective is given greater general value, much greater applied scientific knowledge is needed on the consequences of human intrusion upon natural systems. Based on this knowledge much more sophisticated normative standards than we now have to guide planning and action are needed to achieve, hopefully, a sustainable relationship between man and nature in the future.

ALTERNATIVE FUTURES AND INSTREAM FLOW NEEDS

No official recognition has yet been given to "Limits of Growth" in terms of economic development or population, worldwide or nationally. It has long been the policy of the United States to foster growth in gross national product indefinitely into the future at around 4 percent per year, a bipartisan target. The AFL-CIO in its advice to the platform committee of both major political parties in 1976 has come out against "no growth," and the U.S. Chamber of Commerce has probably done likewise.

There is no official population policy of the United States. The political problem of establishing such a policy has apparently been avoided in recent years by the decline in fertility relative to the death rate. This relationship now points toward no growth after the turn of the century, assuming that net legal and illegal immigration does not vitiate this possible result.

With economic growth compounded at 4 percent per year in the United States indefinitely into the future, to say nothing of the economic growth aspirations and possibilities of the rest of the world, the Environmental Movement's vision of the requirements for maintaining a sustainable relationship between man and natural systems would seem unattainable. Instream natural biological systems would be in great jeopardy, to say the least, unless necessary effluent control is found to be compatible with substantial economic growth.

Without much, if any, overall overt policy control no growth though in per capita real income in the United States, at least, would seem to be a possible alternative future after the turn of the century. Higher relative prices for imported raw materials, combined with eventual fall off of demand from abroad for our products of agriculture, is a good possibility. As real income per capita expands to 2000 the declining marginal utility of material goods, together with an increased demand for leisure cutting the standard work week below forty hours, could set in motion major macro influences on economic growth. The third TV set or automobile is not as important as the first or second. And, in the last century, average hours of work have declined from seventy to forty. There is nothing sacred about forty. The assumption of insatiable economic demand in a developed society is certainly questionable.

No growth in population and in per capita national income after the year 2000 for the Nation as a whole would lessen environmental problems in some parts of the nation and have major environmental implications. But major struggle between development and the environment in the West and South would appear destined to continue. Long term trends in internal migration from the north-eastern and northcentral areas to the West and South could well continue.

No growth means more pressure for recreational experiences, including fish and wildlife, throughout the Nation, but especially in the West where water is relatively scarce. Whether the Nation keeps growing in economic terms or whether it goes into a state of no growth nationally, the struggle to meet instream-flow environmental needs will continue. No national environmental standards have yet been formulated, let alone subjected to the political process, that could do away with this struggle, basin by basin.

REFERENCES

1. For a previous discussion by the author concerning this general subject, see "The Allocation of Water and Related Land Resources," in Urban Demands on Natural Resources (Proceedings of 1970 Western Resources Conference, published by University of Denver), pp. 85-94.

2. For a fuller treatment by the author of the following analysis, see "Colorado River Basin--Policy Goals and Values in Historical Perspective" in Values and Choices: The Colorado River Basin (University of Arizona Press, Tucson; to be published in 1976).

3. See, for example, Walter A. Rosenbaum, The Politics of Environmental Concern, (Praeger, New York: 1973), p. 71.

4. The discussion in this paragraph is based upon the technical views of Paul Ehrlich and John P. Holdren, "We'll Get There," Environmental Conservation, Vol. 2, No. 4 (Elsvier Sequoia S. A., Switzerland), as reprinted in Development Forum, April 1976, published by United Nations, Switzerland.

5. The Nor'Wester, Newsletter of the Pacific Northwest River Basin Commission, March-April, 1976, p. 2.

6. See Federal Register, Vol. 38, No. 174, Part III, Sept. 10, 1973.

7. For the author's emerging views on the need for such changes, see "The Politics of Multiple Objective Planning" in Multiple Objective Planning Water Resources, (Idaho Research Foundation, Inc., Moscow: 1975); and a Report to the National Conference on Water, sponsored by the U.S. Water Resources Council, April, 1975 (U.S. Government Printing Office, Washington, Stock Number 024-001-02798-4: 1976), pp. 180-184.

PROTECTING INSTREAM FLOWS UNDER STATE LAWS

Richard L. Dewsnup
Legal Consultant
Suite 9, Plaza Terrace
455 East Second South
Salt Lake City, UT 84111

I. Introduction

You will forgive me, I trust, if I draw on some experience gained during an earlier part of my life for the introduction to my presentation today. I think this experience is useful to show why, at a rather tender age, I learned to appreciate the necessity of diverting water from the stream to make crops grow, as well as the importance of preserving the watercourse for its environmental and social values.

I was born and raised on the desert of southwestern Utah, where water was scarce and where one naturally developed an appreciation of the vital role of water and the wonders it can perform, whether in or out of the watercourse. Years later, in England, I always enjoyed the rain, because I remembered how important it had been to the needs of the desert, and that there had never been enough, though my companions in England perceived no particular fascination in the daily downpour.

Not all memories associated with water use on the farm were entirely pleasant. I remember irrigating, particularly at night, when the water flooding between the dikes would force the wildlife to seek refuge on the dikes where you had to walk to change the water settings. It never failed to release a little adrenalin into my system when a snake would wind itself around my boot, or when a pheasant or meadow lark would fly up in front of my face in the dead of night.

Instream uses were quite limited in that area. The primary excitement derived from swimming in the river was waiting to see whether you would get typhoid fever. But we did fish in the river in the summer, and we ice skated in winter when it was frozen over.

That river was the Sevier River, which has its headwaters near Bryce Canyon National Park, and which used to terminate in Sevier Lake, a lake that was about thirty miles long and ten miles wide--before diversions from the stream took their toll. The Sevier River system is probably subject to a more intensive use than any stream system in the United States, and Sevier Lake is now totally dry, as is the main stem of the river for about 20 miles upstream from the lakebed. There are simply so many diversions from the river, and so many impoundments on it, that it no longer has sufficient water to reach the old lakebed.

Sevier Lake and the lower reaches of the river were dry from my earliest recollection, and so I have no first-hand knowledge as to what the social values used to be. Indians used to hunt waterfowl there, and I have found arrowheads and pottery along the shores of the dry bed. And my father used to tell me that, when he was a boy, he and his friends would hook a team of horses to a wagon and go to Sevier Lake and spend a couple of days, and shoot enough ducks and geese to fill the wagon box. They would then return home and the waterfowl would be bottled, or "canned" if you prefer the euphemism, for winter use. Of course, that was before conservation laws placed limits on the number of ducks and geese you could shoot.

Perhaps even at that time it was improvident to take wildlife in those amounts, even discounting the story a bit to allow for the exaggerations that sometimes creep into our telling of stories about the good old days. Even so, while I don't think that I would have been too interested in eating bottled ducks all winter, I would have enjoyed the opportunity to hunt when waterfowl was present in such abundance. But waterfowl will never return to Sevier Lake.

I think that you have to live in an area where outdoor esthetic values are scarce before you can truly appreciate the importance of preserving and protecting them. In a humid area like Virginia, where I lived for several years, it seemed that the State was blanketed with trees and grass, and so it was not too disturbing to see trees being removed to clear a construction site. But on the desert, where there are virtually no trees, it was a very sad experience to see hugh cottonwoods, planted by the early settlers, later destroyed because they were considered to be harmful phreatophytes whose roots drew too much water from the stream.

The annual outing that I looked forward to most, as a boy, was the fishing trip that the family would take in June after the hay was cut, hauled and stacked. We always went to Trout Creek, which is in the Deep Creek Mountains of western Utah near the Nevada border. The trip always seemed long across the desert, but it was a rewarding experience, because the stream, though small, was clear and pure, and was loaded with native trout. The banks were lined with willows and birch trees. I did not have a chance to go back to Trout Creek between 1948, when I went away to college, and 1974, when I decided to let my kids experience the same fun I had had in catching those native trout.

But Trout Creek was not the same in 1974. It had been lined with cement, in a rather crude manner, but still effective enough to kill streamside vegetation and fish. The birch trees and willows that had graced the dry bench were gone, no fish could be found, and all that remained was a very long cement trough which carried the water from its canyon source to marginal irrigation uses on the alkali flats below. I am aware of no better illustration of a poorly conceived program to "improve" the use of water resources. It also served as a reminder to me, if I needed one, that you can't go home again.

I have retained an interest in farming, and I still have farm lands and consumptive use water rights. But I realize that the day has not only come, but in fact has long since past, when the public interest demands that environmental and social values of watercourses be considered, preserved and protected in a manner consistent with society's need for orderly economic development.

This brings us, then, to a consideration of the ways in which instream flows may be preserved or protected under state laws. I hope we can prevent this subject from becoming as dry as the bed of Sevier Lake.

II. Examples of Strategies that may be Employed under State Law to Enhance Instream Uses

A. Scope of the Analysis

There are various legal concepts that justify regulation of water use by the states and by the Federal Government. Some of these concepts are based on constitutional considerations, some on statutes, and some on judicial doctrines. In many instances there have been, and still are, conflicts between the United States and the states concerning their respective proprietary rights and regulatory powers. I shall refrain from identifying or summarizing these concepts, because I believe they will constitute the substance of Professor Frank Trelease's presentation tomorrow morning.

It should also be noted that the statutory and regulatory regimes for regulation of water resources vary from state to state. While the appropriation states have very much in common, they also have a significant number of difference. And riparian states differ markedly from appropriation states, although some of the Federal programs, such as those created by the 1972 Amendments to the Federal Water Pollution Control Act, are serving to create some degree of uniformity in some state programs. But time does not permit an exploration in this paper of the differences among the states.

The historic stumbling blocks to protecting instream uses in the western states have been the requirements that water must be (1) physically diverted from the stream and (2) applied to a beneficial use before an appropriation right could be acquired.[/1] These trammels are no longer insurmountable, although in some states legislation is required before effective measures can be implemented to protect instream flows. More difficult questions arise, however, when state constitutional provisions provide, in substance, that appropriation for beneficial use shall never be denied. The Idaho Supreme Court has had no difficulty in finding that protection of instream flows is consistent with its constitutional provison;[/2] but Colorado, which has a similar provision, has yet to answer this question.[/3]

The purpose of this paper is to illustrate various kinds of techniques, approaches and strategies that have been used, or may be used, under state law to protect streamflows. The material that follows is sort of a laundry list of such strategies. The list is not inclusive, and I suspect that different people would compile the illustrations differently, both with respect to the strategies selected and the sequence of their presentation. Be that as it may, it should be remembered that these examples are intended merely to illustrate techniques, and we shall not pause to evaluate the legal ramifications of each technique. Since the audience is comprised of representatives of various professions and disciplines, the task at hand is to survey the practical utility of the strategies selected.

With the foregoing limitations and caveats, let us proceed to the specific strategies.

B. Specific Illustrations

1. Interstate Compacts

Interstate compacts cannot be created unilaterally by a single state, but they result from state action because they are negotiated by states. The United States need not be involved in the negotiation, but Congress must approve such compacts as a constitutional requirement.[4] These compacts should be distinguished from Federal-Interstate compacts, such as those on the Delaware and Susquehanna Rivers, where the United States actually becomes a party to the compact.

Interstate compacts necessarily have an impact on instream flows, because they provide certain allocations and apportionments to the states, and flows adequate to meet these obligations must be sustained. The Colorado River Compact provides, for example, that an average of 7,500,000 acre-feet of water must flow past Lee Ferry in Arizona each year to satisfy lower basin entitlements. /5 These flows also are regulated to some extent by hydrologic criteria which are designed to optimize generation of hydroelectric power in reservoir releases.

The pertinent point, I suppose, is that the conventional wisdom of earlier years failed to take into account the social and environmental values of instream flows when interestate compacts were negotiated; and, to the extent that minimum flows or stream yields are provided for in such compacts, such results were designed to serve purposes other than instream values. It would be appropriate, I think, for States to plan for the protection and enhancement of instream uses as direct purposes of such a compact, along with the allocation and apportionment of waters for economic and consumptive use purposes. This opportunity, and obligation, should be kept in mind when new compacts are negotiated or when existing compacts are amended.

2. Purchases and Contracts

All state wildlife agencies have the authority to enter into contracts to advance and support their statutory missions. With very little imagination, contracts can be negotiated to provide for instream flows. In Utah, for example, the Division of Wildlife Resources has participated financially in the construction of new reservoir facilities, most commonly purchasing conservation pools and public access rights, but in some instances purchasing sufficient water to provide for releases for streamflow augmentation during critical times of the year.

A number of contracts have also been negotiated in reservoirs that were constructed many years ago. In some instances, conservation pools have simply been acquired by buying part of the water rights held by an irrigation company; and in other instances similar rights have been acquired when an older facility has been enlarged or modified. Not all of these arrangements have provided for releases to augment downstream flows, but if such a need had been critical, and if the Division had had sufficient money, such arrangements would have been possible.

There are any number of arrangements that might be consummated through such negotiation. It would be possible in many instances, for example, for a wildlife agency to purchase water shares in a mutual irrigation company and hold such water in storage for release during critical low flow periods, and to sell the released water to users far enough downstream so that the purpose of stream augmentation would have been satisfied. Complications will arise, of course, but in most cases they can be worked out to accommodate the particular concerns of the parties and the hydrologic features of the watercourse.

In short, this avenue of purchases and contracts derived through negotiation should not be overlooked, and it is important not only for new project construction, but also for existing facilities on watercourses where the entire water supply has been fully appropriated.

3. Legislation Protecting Scenic Rivers

Where watercourses have particular scenic and esthetic values, some states have enacted legislation to protect these values. One of the earlier efforts was that of Oklahoma in 1970, known as the Scenic Rivers Act,[6] which provides for protection of certain free-flowing streams which:

> possess . . . unique natural scenic beauty, water conservation, fish, wildlife and outdoor recreational values. . . .[7]

The statute also recites that its purpose is to:

> . . . preserve these areas for the benefit of the people of Oklahoma . . . as a part of Oklahoma's diminishing resource of free-flowing rivers and streams.[8]

The act identifies specific reaches of particular streams and provides for protective measures to perserve natural scenic values, and further provides for the elimination of pollution in these waters. In essence, the statute seeks to maximize public use and the protection of social values, while, at the same time, protecting private rights.

4. Legislative Definition of Navigability

States have regulatory authority over navigation on the navigable waters within their borders. If the waters are navigable waters of the United States, then the state authority is subject to the paramount regulatory authority of the United States; but if the waters are the navigable waters of the states, the state regulatory authority controls the use of the watercourse.[9] Since the public trust over navigable waters extends to all waters that are navigable, a more inclusive test of navigability will extend the public trust to more watercourses.

Many states follow the Federal test of navigability, which requires that the watercourse be capable of supporting commercial navigation.[10] But, for purposes of the public trust, the states are at liberty to declare their own test of navigability, and some have adopted tests much more inclusive than the Federal test. Idaho, for example, has enacted legislation that declares that certain streams are navigable for the purpose of fishing, and, after naming such streams, further provides that every other stream or part thereof will be deemed navigable if:

> . . . logs or timber can be floated to market or the place of use during the high water season of the year. For the purpose of this act, logs and timber are defined as any cut timber having a diameter in excess of six (6) inches; high-water is defined as the time of year when the stream normally carries its greatest volume.[11]

This is, indeed, a very inclusive test. As an aside, it might be worthy of note that a case is now pending before the Idaho Supreme Court which is based in part on this statute, and which involves competing claims for fishery resources. A small inlet on the Snake River was diked and commercial fish ponds were constructed. Since springs flowed into the inlet, a source of fresh water was available to flow through the fish ponds and make it possible to raise trout for sale. An action was filed by private persons, invoking the statute cited above, claiming that the inlet was a navigable water that could not be appropriated for private use to the exclusion of the public. The district court agreed, and ordered that the fish ponds be removed. Since the Idaho Supreme Court has not yet acted on the appeal,[/12] it is too soon to say whether the lower court's decision will be upheld.

5. Judicial Definition of Navigability

In some States, even in the absence of a legislative definition of navigability, the courts have established inclusive tests of navigability, thereby extending the protection of the public trust to all waters falling within the judicial definition. Quite commonly, a "pleasure boat" test of navigability has been applied. Illustrative examples are found in cases decided by the courts of Minnesota,[/13] Wisconsin[/14] and Oklahoma.[/15]

6. State Regulation of Navigation

States have authority to regulate their navigable waters to aid navigation, and, since navigation is an instream use, flows to support navigation might also support wildlife. In the west, where past emphasis has been on diversions and consumptive uses of water, very few efforts have been made to require instream flows sufficient to support navigation. But there is no reason why the states should not now focus more attention on this prospect, particularly in the light of the fact that no compensation would have to be paid to those making diversion from the stream by virtue of the state navigation servitude. /16

To keep things in perspective, let me repeat once more that the Federal Government has superior regulatory power on the navigable waters of the United States and their tributaries, and state regulations cannot conflict with Federal regulations on those waters; but states have sole regulatory authority over navigation on the navigable waters of the states. /17

7. Instream Reservations by State Agency

Some states authorize an agency of the State to withdraw or reserve instream flows sufficient to satisfy instream needs. This is not to say that instream needs have a priority over consumptive use needs, but is to emphasize that administrative action to withdraw or reserve instream flows against other appropriations or diversions is an important technique. In 1969 the

State of Washington authorized the Department of Water Resources to reserve minimum flows for fish, game, and other wildlife resources when requested to do so by the wildlife agencies.[/18]

8. Appropriations by State Agency

In 1969 Montana enacted a statute which authorized the Montana Fish and Game Commission to appropriate water from streams named in the statute, "in such amounts as may be necessary to maintain stream flows necessary for the preservation of fish and wildlife habitat."[/19] This procedure is similar to appropriations made for consumptive uses, but the substantive difference, of course, is that the very purpose of such instream appropriations is to protect the streamflow from excessive diversions.

The 1969 statute went on to provide that such appropriations, when made, would have a priority of right over other uses until such time as the state district court should determine that the water was needed for a use "more beneficial" to the public. And so it was possible for the instream appropriations to be divested by changing circumstances and needs. The most curious provision, it seems, is that which placed upon the district judge the responsibility of determining public policies and priorities to assess which uses are more beneficial to the public.[/20] Ordinarily policy questions such as these are determined by the state legislature, or by administrative agencies with delegated authority to establish such policies, and not by the courts.

It might also be noted that in 1973 Colorado enacted a statute,[/21] popularly known as Senate Bill 97, which recited in its title that it was for the purpose of "providing for the appropriation of water by the State of Colorado to protect the Natural Environment." Section 1 of that statute eliminated the "diversion" requirement for appropriations and enlarged the statutory definition of "beneficial use," which already included fishery and wildlife,[/22] to include "the appropriation by the State of Colorado . . . of such minimum flows between specific points or levels for and on natural streams and lakes as are required to preserve the natural environment to a reasonable degree."[/23]

Another provision authorizes the Colorado Water Conservation Board to make appropriations, on behalf of the people of the State of Colorado, of waters in natural streams and lakes "as may be required to preserve the natural environment."[/24] Before doing so, however, the Board must request the recommendations of the Division of Wildlife and the Division of Parks and Outdoor Recreation.

9. Statutory Moratorium on Appropriations and New Diversions

State water records do not have the accuracy and reliability that real estate records do, and it is often difficult to determine with any degree of accuracy the extent to which the waters of a stream are appropriated.[/25] Moreover, in some instances the hydrologic data and flow records for the stream need further supplementation, refinement and evaluation to assess fully the available water supply.

Because of factors such as these, it becomes difficult to determine the amount of unappropriated water that might be available for withdrawal or reservation to protect instream flow needs. As a result, in some instances it might be advisable to declare a moratorium on further appropriations pending a study of present appropriations and prospective needs for diversions and instream flows.

Montana, for example, provided for such a moratorium on the Yellowstone River in 1974, when it enacted a statute which withdrew the waters of that river from further appropriation for a three-year period, during which time a thorough study was to be made of the available water supply and present and prospective water-use needs, including instream flow needs. [/26] Applications to appropriate pending at the time of the enactment cannot be acted upon until the study is completed. One of the applications now pending was filed by the Montana Fish and Game Commission on March 4, 1974, and it requests a substantial reservation of flows to preserve instream values. The recommended minimum streamflow would yield an annual discharge at Billings in the amount of 3,800,000 acre-feet, 6,300,000 acre feet at Miles City, and 7,000,000 acre-feet at Sidney.

10. Administrative Moratorium on Appropriations and Diversions

Sometimes states have general legislation which authorizes an administrative withdrawal of unappropriated waters. Some of these statutes were enacted long ago when instream values were of no particular concern, and when diversions and economic uses were paramount concerns. However, the language in a Utah statute seems to be sufficiently broad to permit an administrative withdrawal of water to protect instream values. /27 That statute provides that when the State Engineer and Governor jointly agree that the "welfare of the state demands it," the Governor can preserve the surplus and unappropriated waters of any stream "for any use whatsoever" by suspending "the right of the public to appropriate such surplus or unappropriated waters." It seems plausible that this statute could be dusted off and used to protect instream values.

11. Conditions in Water Use Permits

Another technique is to impose conditions and restrictions when water use permits are issued or when applications to appropriate are approved. These conditions and restrictions could be designed to protect important instream flow needs, and this could be done whether the permit was for the construction of a reservoir or simply for direct diversion from the stream.

In the case of a reservoir, the permit might require that a minimum flow be sustained through reservoir releases as a condition to construction of the reservoir; and, in the case of direct diversion permits, it could be stipulated that there would be no right to divert when the stream fell to a certain level or to a flow of a specified number of cubic feet per second. California has used this technique, and it seems to hold promise for states that have not yet considered it.[28]

12. Conditions on Transfers

One feature of an appropriation water right is that it may be sold and transferred, and sometimes the purchaser desires to change the point of diversion, place of use, or nature of use (such as from an irrigation use to a municipal or industrial use). And sometimes the owner of the water right will desire to make such changes without actually selling the water right to another party.

It would seem to be appropriate to consider the impact of any such proposed change or transfer on the natural stream environment, and to approve such changes and transfers only when such impact is not reasonable or unduly harmful. Colorado,[29] Montana[30] and Utah,[31] through differing devices, seem to be taking such an approach.

13. Conditions on Exchanges

Exchanges must be distinguished from transfers and changes. The latter relate to changes and transfers in water use on the same source of supply where the original appropriation was made, whereas exchanges contemplate moving the water right to a separate source of supply.[32] Most commonly, this arises when a proposal is made to move the water right from the main stem to a tributary, or from a tributary to the main stem, or from one tributary to another.

There seems to be no reason why the same environmental considerations that might be applied to changes and transfers could not also be applied to applications for exchanges.

14. Prohibitions on Transfers and Changes

Montana seems to have gone the furthest in restricting transfers and changes by enacting a statute in 1975 which prohibits transfers from agricultural to industrial use when the amount involved exceeds 15 cubic feet per second./33 While I have refrained from commenting on the legal aspects of the mechanisms discussed, I must say that there are serious questions concerning the constitutionality of this statute. If it is valid, then I suppose that a similar prohibition could be imposed on exchanges.

15. Permits for Limited Periods of Time

Traditionally, appropriation water rights have been acquired in perpetuity, without regard to the period of time that the appropriator actually needs to use the water in order to satisfy the purpose of the appropriation. In many cases it is obvious that the appropriator does not need to use the water in perpetuity. A mining operator will not need the water after the ore body is mined out; a sand and gravel washing operation might be commenced for the sole purpose of a single construction project, such as a major dam; and many similar illustrations could be cited.

The question, of course, is whether a water right acquired for such purposes should be in perpetuity or only for the period of time required to satisfy the intended use. If awarded in perpetuity, the owner most likely will sell and transfer the right when he no longer has a use for the water; but if awarded only for the period of time required to satisfy the original use, the water would return to the watercourse after expiration of the permit, and would be available to satisfy instream flow needs or other benericial purposes. And, as a general proposition, such fixed-period permits would give the state water rights administrator a good deal more flexibility in allocating and reallocating the water resource.

In some states such fixed term permits may be implemented without specific statutory authorization, so long as there is general authority to approve water applications and there is no direct conflict with any other statutory provision. I think, for example, that the Utah State Engineer would have had such authority, but the question is now moot because the Engineer sought and received express legislative authority [34] to approve applications for fixed periods of time--although the farm lobby succeeded in getting agricultural uses exempted from this provision.

Thus, the implication of the statute now is that water rights acquired for agricultural purposes must be in perpetuity, whereas, prior to the statute, there was no such implication, and it is likely that the State Engineer could have imposed fixed periods on all water appropriations, whether for agriculture or otherwise.

It is not entirely clear to me, however, that the exemption for agricultural uses will be an unmitigated boon to farmers. The State Engineer must still evaluate all applications to determine, among other things, whether the proposed use will interfere with the more beneficial use of water and whether it will prove detrimental to the public welfare. It seems quite possible that an application to appropriate water in perpetuity for irrigation purposes might conflict with more beneficial uses of water in the future, and might otherwise prove detrimental to the public welfare--whereas an application to appropriate water for an irrigation use for a fixed period of time, say 20 years, might not. In such an event, the application might be denied, whereas it might have been approved for a limited period of time if the statute had not provided the exemption.

16. Statutory Criteria to Protect Instream Values

Another technique for considering and protecting instream values is realized through statutory criteria which require the administrative officer to reject any application to appropriate when it appears that it would unreasonably interfere with instream flow needs. It is important to visualize that, under this technique, it is the legislature that requires instream values to be considered, but it is the administrator who actually determines whether any specific proposal to divert water would result in an unacceptable impairment of instream values.

Utah enacted such a statute in 1971,/35 wherein an additional criterion was added to those previously in effect. The pertinent part of the 1971 amendment provided that any application to appropriate water must be rejected by the State Engineer if, after investigation, he determines that such proposal would "unreasonably affect public recreation or the natural stream environment."

17. Enlightened Administrative Interpretation of Broad Statutory Criteria

Even though, historically, state administrative officers have not been concerned with instream values when acting on applications to appropriate water, it is quite possible that they have had authority to take such values into consideration. The administrative officers almost always have had authority to take the "public interest" into consideration, but they often took a narrow view as to what the public interest was. Most administrative officers have authority to promulgate rules and regulations to implement the statutory authority vested in them, and it seems entirely appropriate for such officers to set forth in their regulations the criteria which will be used to ascertain the public interest. And there is no reason why these criteria cannot embrace instream values.

The Utah State Engineer has distributed for public comment a preliminary draft of rules that contain such provisions, but he has not yet taken any final action to approve and implement them. The pertinent observation is that the Utah State Engineer has been required for many years to determine whether a proposal to appropriate water would interefere with the "more beneficial use" of water or would be "detrimental to the public welfare," but he had never taken any steps to define these broad criteria or to develop any specific criteria by which they could be determined. The new regulations, as proposed in draft form, would require an evaluation of positive and negative impacts on economic, social, recreational and environmental values that would result from the proposed use,[/36] in addition to other specific criteria set forth in the review draft of the regulations.

It might be observed that in 1971 the Utah legislature added an additional statutory criterion, mentioned earlier, which required the State Engineer to reject any application that would have an unreasonable affect on public recreation or the natural stream environment. But the new draft rules now under review, it seems to me, would have been authorized by the earlier legislation.

Some questions might arise under this mechanism when instream flows are preserved and applications to appropriate are denied when there is unappropriated water in the source, and these questions will depend on the particular state. Questions as to the "diversion" requirement and "beneficial use" concept might still arise in some states, although the answer seems to be that the instream flow is not an "appropriation" under this strategy. The administrative officer has simply determined that the public interest would be better served by leaving the water in the stream. It must be conceded, however, that where instream values are not "beneficial uses," it would be difficult to sustain administrative action which denies a proposed appropriation that would qualify as a beneficial use, for the purpose of protecting a public value that does not qualify as a beneficial use.

18. Imposing More Stringent Burden of Proof on Large Applications to Appropriate

Montana has devised a mechanism, apparently designed to protect instream values, which imposes a more severe burden of proof on those appropriators who seek to appropriate flows in excess of 15 cubic feet per second.[/37] The traditional requirement in most states has been that an applicant must make at least a prima facie showing that there is sufficient unappropriated water in the source to satisfy his proposed appropriation, but the Montana statute goes further by requiring a clear and convincing showing that the appropriation would not interfere with other water rights.[/38] It must be borne in mind that the Montana Fish and Game Commission is authorized to acquire instream rights, and so any applicant who desires to divert 15 cubic feet per second, or more, must make a clear showing that any instream rights so held by the Commission will not be impaired. In many cases, this might be an insurmountable burden.

19. Demanding Increased Efficiency in Existing Uses before Allowing further Stream Depletions

Appropriation law has always required water users to employ a reasonable degree of efficiency in their use of water, so as to avoid waste. Indeed, the very concept of "beneficial" use contemplates that the method of diversion, means of conveyance, and application to use will be reasonable so that quantities of water in excess of those beneficially required will not be diverted from the stream. Courts have generally been quite liberal in construing this requirement, however, and in many cases rather substantial losses--particularly in conveyance systems--have been sustained as being reasonable.[/40]

The time has now come, it seems to me, when we should take a more careful look at the efficiency of use. New technologies have provided new and improved ways of diverting, transporting and using water. Methods that were reasonable a half-century ago, or even ten years ago, might no longer be reasonable in light of potential improvements that are now feasible. It also seems sound, in fact necessary, to consider the increasing demands now being placed on the resource--including demands for instream uses.

I think the possibilities of imposing more stringent requirements on efficiency of use are well illustrated by the decision of an intermediate appellate court in California.[/41] In that case a water district sought to withdraw additional water from the American River, but was met with opposition by an environmental organization which claimed (1) that the district could satisfy its need for additional water by reclaiming and recycling its existing supply, and that (2) further stream depletions would have adverse environmental impacts. The court noted that the California constitution[/42] requires that waste, unreasonable use, or unreasonable method of use of water be prevented, and held that to the fullest extent possible all waters within the state should be put to beneficial use.[/43] So holding, the court remanded the case for trial on the merits.

20. Demanding Greater "Diligence" in Completing Appropriations

Under the laws of most western states, when the first step is taken to acquire a water right the appropriator acquires an inchoate right, and he may then complete or perfect his appropriation free from interference by subsequent appropriators, so long as he proceeds with "reasonable" or "due" diligence. In the first instance, the question as to whether there has been reasonable diligence is determined by the administrative officer, with subsequent judicial review.

But administrative officers ordinarily are given wide discretion in deciding what is reasonable, and some have allowed unperfected appropriations to pend for many years. The Utah statute,[/44] for example, allows the State Engineer to keep pending appropriations alive for 50 years, and, even then, if the works are fully constructed additional time may be granted within which to apply the water to beneficial use.

The Utah State Engineer, in his draft rules distributed for review, has indicated a much more demanding position by requiring prompt completion of appropriations, and by indicating that he will consider such things as environmental values and instream flow needs in deciding whether an appropriator should be granted additional time within which to complete the appropriation.[/45]

From the standpoint of instream flow values, it should be noted that waters cannot be reserved or withdrawn for instream use unless there is unappropriated water in the stream. When water is "obligated" by numerous unperfected appropriations, the water is still in the stream but it is not available for allocation to instream uses. In many instances, the old, unperfected appropriations could be lapsed and cancelled for lack of diligence, and there then might be unappropriated water that could be reserved for instream values.

21. Private Instream Appropriations

Another strategy is that of allowing private persons to make appropriations of instream flows. While a number of arguments could be mounted in favor of, and against, this approach, I personally do not favor it because there appear to be so many preferable mechanisms and strategies available. That approach seems similar to the private riparian rights of Eastern states. I confess that I feel that instream flows in natural channels yield public values that should be reserved and protected for and in the name of the public, rather than private parties.

Nevertheless, the State of Washington feels otherwise, and a private appropriation of an instream flow has been recognized as lawful.[/46] Consequently, it appears that this avenue cannot be ignored.

22. Additional Strategies and Techniques

Time does not permit a discussion of further strategies and techniques, but I would like briefly to identify some remaining mechanisms and procedures that have important implications for instream flows.

a. Weather Modification

Many states have operational weather modification programs to augment water supply,[/47] and instream flow needs should be considered along with other needs in deciding how the new supply of water should be allocated.[/48]

b. Watershed Management

In the western states watershed management is primarily a function of the Forest Service and the Bureau of Land Management, but in some areas significant parts of watersheds are owned by the states, and state and county zoning regulations and other land use controls can play a meaningful role. While the tail cannot wag the dog, the relationship of watershed management practices to instream flow needs should be considered in establishing the criteria and programs for the watersheds.[/49]

c. Intrastate Transbasin Diversions

It is not uncommon for water to be transported from one basin to another within a particular state. The exporting basin will experience a depletion in its water supply, and the importing basin will experience an augmentation of its supply. The impacts on instream flows in both basins should be evaluated before the diversion is made; and, if made, measures to satisfy instream flow needs in the importing basin should be considered as part of the project purposes.[/50]

d. Protection of Streambeds

State statutes which protect streambeds from alteration and relocation are now rather common.[/51] While these statutes do not augment, preserve or protect instream flows, they do protect habitat and spawning areas for fish, and are thus of considerable importance to the value of the instream flow. A minimum streamflow is not too significant, from the point of view of the fish, if the bed of the stream has been lined with cement.

e. Water Quality Control

While many state water quality control programs are prompted, and to some extent controlled, by PL 92-500, other state water quality programs are within the discretion and control of the states. And some states have adopted administrative procedures whereby fish and wildlife needs are considered as part of the water quality planning process.[/52] As such, administrative action can be taken not only to control the quality of water in the stream, but also to establish minimum flows for fish and wildlife needs. [/53]

f. Planning Programs under Section 208 of PL 92-500

The planning programs under Section 208 [/54] of PL 92-500 are just getting under way. These programs are conducted by state and local representatives in the planning process, in accordance with the board mandate of Section 208 and regulations promulgated thereunder. In essence, these programs are state planning processes, and now is the time for advocates of instream flows to take appropriate steps to make sure their views are heard and considered in these planning programs. [/55]

g. Pumping Groundwater to Augment Streamflow

Groundwater can be a valuable source of augmentation for the flow of surface streams, either as part of a water management plan (conjunctive use of surface water and groundwater), or as an isolated operation. [/56] In some cases, particularly on the lower reaches of a stream, groundwater has been pumped to augment the flow of the stream, with benefits to instream needs as well as to downstream users who divert from the stream.

h. Requiring Consideration of State Water Plan

All of the states have developed, or are in the process of developing, state water plans, ordinarily with financial assistance provided by the Federal Government through the Water Resources Council, under the provisions of the Water Resources Planning Act of 1965.[57] To the extent that these plans provide for protection of instream flows, it is important that appropriate legislation require the water rights administrator to consider the state plan when deciding whether appropriations should be approved or rejected.[58]

i. Evolving Water Use Plan to Regulatory Status

If it is deemed desirable to accord regulatory status to the state water plan, then rather formal procedures must be followed to develop and adopt the plan.[59] I think that this technique has significant potential for placing all water uses, including instream flows, in a proper balance to protect the entire spectrum of the public interest. In the past, there has been far too much "daylight" between the planning process and regulatory procedures.[60]

j. Water Management Districts

Strange to say, several eastern states have advanced beyond the western states in creating water management districts as integrated entities to plan, administer and regulate water use.[61] This technique might be the ultimate in water management, and might be a very effective means of protecting instream flows, as well as providing for diversions and economic uses. The primary reluctance of western states to adopt such management districts has stemmed from the resistance of those holding appropriation rights, who fear that their rights might be jeopardized or diminished by the creation of such districts.

This fear is unfounded. Management districts might well plan and implement programs for augmentation of water supply to the benefit of all. This augmentation might result from weather modification programs,/62 integrated use of surface water and groundwater to maximize supply,/63 water savings practices and techniques,/64 basin imports,/65 and a variety of other possibilities.

k. Little NEPAs (SEPAs)

Some states have enacted statutes patterned after the National Environmental Policy Act./66 These statutes commonly have the effect of requiring a consideration of the environmental values of instream flows before state action is taken to authorize the diminution of depletion of such flows.

l. State Fish and Wildlife Coordination Acts

Some state legislation is patterned, to a considerable extent, after the Federal Fish and Wildlife Coordination Act,/67 so that fish and wildlife values are to be given equal consideration with economic values when water projects are licensed or constructed by the state.

m. Appropriations held in Trust for other Uses

A statute in Utah authorizes a state agency to acquire water rights for no other purpose than to hold such rights in trust for subsequent assignment to users./68 This might seem to be a rather awkward technique, but it has had the effect of preserving a water supply in some streams that otherwise would have become fully appropriated. And now, when such water rights are assigned to others, environmental and instream values are seriously considered and reasonable protective measures are provided,/69 even though I am sure the original legislation did not contemplate the protection of such values./70

n. Acquisition and Re-Allocation of Water Rights

If there seems to be no other way to augment a stream flow that already has been severely depleted, and the need for augmentation is substantial with a promise of sufficient benefits, then it would be possible to acquire existing water rights and re-allocate the water for flow augmentation through the critical stretch of the stream. The state could acquire such rights by purchase or condemnation./71

III. Conclusion

In the preceding discussion I have identified 35 separate strategies and techniques that, to varying degrees, might prove useful in preserving, protecting and enhancing instream flows for fish and wildlife purposes. But we have only scratched the surface. Many other techniques and strategies can be found, perhaps some more effective than any I have mentioned. The field is fertile for those researchers who are interested in state water law and who believe that a fair share of the water resource must be preserved to protect instream values.

NOTES

1. Dewsnup, Legal Protection of Instream Water Values (National Water Commission, 1971).

2. State Department of Parks v. Idaho Department of Water Administration, 96 Idaho 440, 530 P.2d 924 (1974). The provision construed was Article 15, Section 3, of the Idaho constitution.

3. The similar provision in the Colorado constitution is Article 16, Section 6. A Colorado statute provides for appropriation of water by the state to protect instream flows (Section 37-92-102(3), Colo. Rev. Stat. Ann.), but the Colorado Supreme Court has not had occasion to determine whether the statute violates the consitutional provision. Other states have milder constitutional provisions in support of appropriation (Wyoming constitution, Article 8, Section 3; Nebraska constitution, Article 15).

4. United States Constitution, Article 1, Section 10, para. 4.

5. Colorado River Compact of 1922, Article III(a).

6. Okla. Stat. Ann., Title 82, § 1451-59.

7. Id. at § 1452.

8. Ibid.

9. The Daniel Ball, 10 Wall, 557 (1870).

10. Id. at 563.

11. Idaho Code Ann., § 36-907.

12. Ritter, et al. v. Standal, et al, Case No. 11971, pending in Idaho Supreme Court. See Southern Idaho Fish & Game Ass'n v. Picabo Livestock, Inc., 96 Idaho 360, 528 P.2d 1295 (1974).

13. Lamprey v. State, 52 Minn. 181, 53 N.W. 1139 (1893), as subsequently modified in State v. Adams, 251 Minn. 521, 89 N.W.2d 666 (1958). See also State v. Bollenbach, 241 Minn. 103, 63 N.W.2d 278 (1954).

14. Diana Shooting Club v. Husting, 156 Wis. 261, 145 N.W. 815 (1914).

15. Curry v. Hill, 460 P.2d 933 (Okla. 1969).

16. See, e.g., Colberg, Inc. v. State of California, 67 Cal.2d 408, 62 Cal. Rptr. 401, 432 P2d 3 (1967); Southern Idaho Fish & Game Ass'n v. Picabo Livestock, Inc., 96 Idaho 360, 528 P.2d 1295 (1974); Commonwealth v. Thomas, 427 S.W.2d 213 (1968).

17. PL 92-500, 33 U.S.C. 1251 _et seq._, extends federal regulatory authority over water quality to all navigable waters and their tributaries, whether navigable waters of the United States or navigable waters of the states. This jurisdiction apparently is based on general Commerce Clause power and not on the narrower power to regular navigation. See _United States v. Ashland Oil and Transportation Company_, 504 F.2d 1317 (C.A. 6, 1974). The United States Supreme Court has not yet ruled on the constitutionality of the broad jurisdictional reach of PL 92-500.

18. Rev. Code Wash. § 90.22.010.

19. Mont. Rev. Code § 89-801(2); repealed in 1973, now see § 89-890.

20. _Ibid_. The statute provided that instream appropriations for fish and game purposes "shall have a priority of right over other uses until the district court in which lies the major portions of such stream or streams shall determine that such waters are needed for a use determined by said court to be more beneficial to the public." For present provisions see § 89-890.

21. Colo. Rev. Stat. Ann. § 37-92-102(3).

22. _Id._, § 37-92-103(4).

23. _Ibid_.

24. Colo. Rev. Stat. Ann. § 37-92-102(3).

25. Dewsnup and Meyers, _Improvement of State Water Records_ (National Water Commission, 1971).

26. Mont. Rev. Code § 89-8-103 (1974).

27. Utah Code Ann. § 73-6-1.

28. _California State Water Resources Control Board Decision_ No. 1379 (1971); _Bank of America Nat'l Trust & Savings Ass'n v. State Water Resources Control Board_, 42 Cal. App. 3rd 198, 116 Cal. Rptr. 770 (1974); and see Cal. Water Code § 1243 (1975 Supp.).

29. Colo. Rev. Stat. Ann. § 37-92-102(3) authorizes the Colorado Water Conservation Board to appropriate instream flows for fish and wildlife purposes, but the streams of Colorado are fully appropriated. This would seem to mean that the Board will have to appropriate streamflows as they now are, so that there will be no interference with vested rights. But when the owner of a water right desires to transfer the point of diversion, it will be necessary to determine whether such a transfer would interfere with the "junior" instream

right held by the Board. If so, the transfer would be denied, or adjusted in such a manner as to avoid any interference.

30. Mont. Rev. Code §§ 89-890, 892.

31. The Utah State Engineer has promulgated draft rules for public review and comment, but has not yet finalized or adopted these rules. These draft rules would require consideration of the natural stream environment when any request for transfer is filed.

32. Utah Code Ann. § 73-3-20.

33. Mont. Rev. Code § 89-892(3).

34. Utah Code Ann. § 73-3-8.

35. Ibid.

36. Preliminary Draft of Rules to Supplement Rules of Utah State Engineer Adopted February 8, 1974.

37. Mont. Rev. Code § 89-885(6).

38. Ibid.

39. Dewsnup, Legal Aspects of Water Salvage (National Water Commission, 1971).

40. Ibid.

41. Environmental Defense Fund v. East Bay Municipal Utility District, 8 ERC 1535 (Cal. Ct. App. 1975).

42. California constitution, Article 14, Section 3.

43. Environmental Defense Fund v. East Bay Municipal Utility District, note 41 supra.

44. Utah Code Ann. § 73-3-12.

45. Proposed Rule No. 2; see note 36 supra.

46. A decision by the Washington Pollution Control Hearing Board has allowed such a private appropriation for research related to raising fish. See the discussion of such decision in Trelease, Water Law, pp. 37-38 (2d ed. 1974).

47. For a comprehensive discussion of weather modification programs and associated legal implications, see The Legal Implications of Atmospheric Water Resources Development and Management (Bureau of Reclamation, October 1968).

48. The most practical means of allocation would be through negotiated agreements with water users and funding agencies. See section II.B.2 of this paper, supra. Since most operational programs receive public funds, there would seem to be ample justification to provide for public uses such as instream flows.

49. See Land Use and Wildlife Resources, pp. 149-180 (Special Problems of Waters and Watersheds) (National Academy of Sciences, 1970).

50. This is particularly appropriate where public funds are used to aid in construction of the project, as is usually the case. Compare section II.B.22.1 of this paper, infra.

51. One of the first statutes of significance was passed by Montana in 1963, as Chapter 258, Mont. Sess. Laws 1963, amended in 1965 and codified in Rev. Code Mont. 26-1501 through 1507, and since amended. Now see 26-1501 through 1509, and the 1975 enactment of 26-1510 through 1523.

52. See section II.B.7 of this paper, supra.

53. Rev. Code Wash. § 90.22.010.

54. 33 U.S.C. 1288.

55. The Section 208 programs necessarily will develop both water use plans and land use plans in order to control water quality, and there inevitably will be conflicts between these plans and state water rights administration.

56. In some instances irrigation companies have simply filed for underground water permits upstream from the point of intended use, and have drilled wells and pumped water into the watercourse, thus augmenting the instream flow until such pumped water was diverted at the downstream point of use.

57. 42 U.S.C. 1962 et seq.

58. Too often water planners proceed to plan and water administrators proceed to administer, with little or no consultation. If water use planning develops useful data or meaningful alternatives for allocation of the water supply, the administrative officer should at least be required to consult the fruits of such planning, even though he is not bound by any recommendations or findings of the planning agency.

59. See Dewsnup and Jensen, Proposed Procedures for Planning, Allocating and Regulating Use of Water Resources in Utah, Vol. One, Chapter Two (Utah Division of Water Resources, 1975).

60. *Id.*, Volume One, Chapter One.

61. Florida is perhaps the best example. See Florida Water Resources Act of 1972, Florida Laws 1972, ch. 72-299, compiled as §§ 373.013 through 373.616 of Florida Statutes.

62. See section II.B.22.a of this paper, *supra*.

63. The water savings implications can be substantial. Underground reservoirs can be replenished during years of high surface runoff, and then can be drawn upon in years of low surface runoff. A variery of similar benefits can be realized. But if one set of water users has rights in surface sources of supply, and a separate set of water users has rights in an underground basin, with no integrated or coordinated management, then these prospective benefits cannot be realized.

64. See, *e.g.*, section II.B.19 of this paper, *supra*.

65. See section II.B.22.c of this paper, *supra*.

66. 42 U.S.C. 4321-4347.

67. 16 U.S.C. 661-667e.

68. Utah Code Ann. § 73-10-19. The Board of Water Resources is authorized to file applications with the Division of Water Rights (State Engineer).

69. These protective measures are provided by contract or by conditions and limitations contained within the instrument of transfer and conveyance.

70. The statute (see note 68, *supra*) provided that such applications would be acquired by the Board for potential future development, suggesting that instream uses were not contemplated by the statute. It might be noted that if the State Engineer approves these applications, they are not perfected because the water is not diverted and placed to a beneficial use by the Board. The applications thus remain as approved but unperfected until assigned. Then, after the appropriation is perfected by the assignee, a certified right may be acquired pursuant to a proper proof of appropriation.

71. This is easier said than done. State legislatures ordinarily are reluctant to grant the power of eminent domain for the purpose of acquiring private water rights. Moreover, the severance damage would be extremely high in most cases, because the remainder of the economic unit would have very little value. Thus, if irrigation rights are condemned, the farm land has little value without water, and the farm buildings and improvements similarly are diminished in value. These damages must be paid, in addition to the damage award for the value of the water right.

FEDERAL INSTREAM FLOW RIGHTS

Walter Kiechel, Jr.
Deputy Assistant Attorney General
Land and Natural Resources Division
Department of Justice
Washington, D. C.

ABSTRACT

The National Conference on Water held in Washington, D. C. in 1975 concluded that State water laws should be changed to recognize a water right for maintenance of the stream for recreation uses, for fish and wildlife, or scenic beauty. The Conference also concluded that there is an urgent need to resolve the uncertainty in quantity and nature of Federal and Indian reserved water rights.

Relating quantification to the subject of instream flows, and in particular to the legal basis for such, the quantification bill prepared by the Department of Justice would provide an inventory of those rights along with all others. It would not provide any independent legal basis for instream flows, either as a matter of state or federal law. The quantification bill is a procedural one, not one conferring substantive rights. In the absence of a systematic quantification of instream flows by such an inventory, it will be done piecemeal by adjudication.

Statutory basis for federal instream flows rights include the Wild and Scenic Rivers Act of 1968, the Organic Administration Act of 1897, and the Multiple Use-Sustained Yield Act of 1960.

With respect to case law, it is under the reserved rights doctrine, recently reiterated by the Supreme Court of the United States in Arizona v. California, 373 U.S. 546 and United States v. Eagle County District Court, 401 U.S. 520, that the United States claims minimum stream flows on not only forest reserves but on other federal reservations. Moreover, there is a growing body of case law in the lower federal courts supporting federal water rights for recreational and aesthetic purposes. In addition to these federal cases, there are certain decisions in the state courts which recognize federal instream flow rights.

The United States is blessed with two happy circumstances: (1) extensive federal ownership of lands and appurtenent water resources; and (2) the existence of a viable legal doctrine, the reserved rights doctrine, by which these lands and waters can be devoted in an orderly way to the purposes of recreation, fish and wildlife and purely aesthetic or scenic enjoyment.

FEDERAL INSTREAM FLOW RIGHTS

I want to compliment the sponsors of this Symposium and Specialty Conference on Instream Flow Needs for their bringing together experts of various fields to focus upon this emerging matter of national importance. As one who has participated in many water law conferences, it is a pleasure to have something new to talk about.

RECOGNITION OF THE IMPORTANCE OF INSTREAM FLOWS

Many of you were present at the National Conference on Water held in Washington, D. C. about a year ago. There assembled were various panels of experts to consider the adequacy of existing water policies and programs. One such panel addressed itself to water law, water rights and institutional arrangements. One of the conclusions of that panel of experts with respect to State water law was that it should be changed to recognize a water right for maintenance of the stream for recreation uses, for fish and wildlife, or scenic beauty. This recommendation was articulated in the Executive Summary of the National Conference on Water promulgated by President Ford as follows:

> 17. Legislation should be developed that recognizes and protects instream uses for scenic, recreation and fish and wildlife concerns.
>
> Such non-consumptive instream uses are not recognized by many States as uses for which water rights can be established, despite the

> fact that there is near universal agreement that some water is necessary for such in-stream uses.

"Near universal agreement" is hard to come by in the water field, but I think that this is not an overstatement.

The recommendation immediately preceding is also relevant here. It is:

> 16. <u>There is an urgent need to resolve the uncertainty in quantity and nature of Federal and Indian reserved water rights.</u>
>
> The uncertainty in the quantity and nature of Federal and Indian reserved rights is one of the greatest present inhibitions to more efficient utilization of the water resources of the West. An early determination of the reserved rights is needed so that the issues can be settled and potential users can plan for the future.

QUANTIFICATION OF FEDERAL WATER RIGHTS INCLUDING INSTREAM USES FOR SCENIC, RECREATION AND FISH AND WILDLIFE

The Department of Justice drafted, at the request of Secretary Rogers C. B. Morton, then Chairman of the Water Resources Council, a bill to provide for the quantification of all federal water rights. This bill has been opposed by the states. I am not here to help bury the so-called "Kiechel Bill." I come to praise it. It would be a mechanism by which the water rights of the Federal Government could be inventoried and would promote optimum utilization of the water resources of the Nation.

Relating quantification to the subject of instream flows, and in particular to the legal basis for such, the quantification bill would provide an inventory of those rights along with all others. It would not provide any independent legal basis for instream flows, either as a matter of state or federal law. The quantification bill is a procedural one, not one conferring substantive rights. In the absence of a systematic quantification of instream flows by such an inventory, it will be done piecemeal by adjudication. I will discuss some of the pending adjudications in connection with my discussion of the legal basis of instream flows.

FEDERAL LAW ON INSTREAM FLOWS

Statutory.

1. Wild and Scenic Rivers Act of 1968.

Starting from the most recent statute and the most specific one, this Act expressly legislates minimum stream flows. The Congressional Declaration of Policy incorporated in that Act states as follows:

> It is hereby declared to be the policy of the United States that certain selected rivers of the Nation 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, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations.

This policy is carried forward in the subsequent action of the Act which says that a river area eligible to be included in the national wild and scenic river system must be a "free-flowing stream." (16 U.S.C. Sec. 1273(b))

2. Organic Administration Act of 1897.

Going back further in time, the national forests included a purpose of instream flows. Although stated in the negative the Organic Act provided as follows:

> . . . . No national forest shall be established, except to improve and protect the forest within the boundaries or for the purpose of securing favorable conditions of water flows, . . .
> (16 U.S.C. 475)

3. Multiple Use-Sustained Yield Act of 1960.

This Act provides as follows:

> It is the policy of the Congress that the national forests are established and shall be administered for outdoor, recreation, range, timber, watershed, and wildlife and fish purposes.
> (16 U.S.C 528)

I shall not extend this discussion with other statutes dealing with forest reserves since that is the subject matter of another presentation.

Case Law.

1. Supreme Court of the United States Decisions.

It is under the reserved rights doctrine, recently reiterated by the Supreme Court of the United States in Arizona v. California, 373 U.S. 546 and United States v. Eagle County District Court, 401 U.S. 520, that the United States claims minimum stream flows on not only forest reserves but on other federal reservations.

In Arizona v. California, the Special Master in his report found that the National Forests in the Lower

Colorado River Basin were established for the following purposes:

> (1) the protection of watersheds and the maintenance of natural flow in streams below the sheds; (2) production of timber; (3) production of forage for domestic animals; (4) protection and propagation of wildlife; and (5) recreation for the general public. (Report of Special Master Simon H. Rifkin dated Dec. 5, 1969, p. 96)

The Special Master also found with respect to National Parks, Monuments and Recreation Areas, within the Lower Colorado River Basin, that water was used thereon for recreation, stock and wildlife watering, among other uses. Ibid. With respect to Lake Mead National Recreation Area, the Master opined: (Ibid. pp. 292-293)

> I conclude that the United States had the power to reserve water in the Colorado River for use in the Lake Mead National Recreation Area for the same reasons that it could reserve such water for Indian Reservations. Although the authorities discussed above which establish the reservation theory all involved Indian Reservations, the principles seem equally applicable to lands used by the United States for its other purposes. If the United States can set aside public land for an Indian Reservation and, at the same time, reserve water for future requirements of that land, I can see no reason why the United States cannot equally reserve water for public land which it sets aside as a National Recreation Area. Cf. F.P.C. v. Oregon, 349 U.S. 435 (1955). Certainly none of the parties has suggested a tenable distinction between the two situations.

The Supreme Court in its decision in Arizona v. California held as follows:

> The Master ruled that the principle underlying the reservation of water rights for Indian Reservations was equally applicable to other federal establishments such as National Recreation Areas and National Forests. We agree with the conclusions of the Master that the United States intended to reserve water sufficient for the future requirements of the Lake Mead National Recreation Area, the Havasu Lake National Wildlife Refuge, the Imperial National Wildlife REfuge, and the Gila National Forest. (373 U.S. 546, 601).

When the Eagle County cases came before the Court, a few years later, the question was the applicability of the statutory consent to join the United States in water adjudications to reserved rights. Attention was focused on a wide variety of non-Indian reserved rights. The Court said:

> The Forest Service administers four separate national forests in the area: the White River, Arapaho, Routt and Grand Mesa-Uncompahgre. The Department of the Interior through the Bureau of Reclamation, the National Park Service, the Bureau of Land Management, the Bureau of Mines, and the Bureau of Sport Fisheries and Wildlife, make use of water in Water Division No. 5 for national recreational and other purposes. (Emphasis supplied; United States v. District Court in and for Water Division No. 5, et al., 401 U.S. 520, 528-9 (1971).)

Accordingly, it is difficult to see how anyone can exclude "recreational" uses from federal reserved water rights.

Moreover, there is a growing body of case law in the lower federal courts supporting federal water rights for recreational and aesthetic purposes. Some of these decisions antedate the decisions of the U.S. Supreme Court in Arizona v. California and Eagle County. In the case of Glenn v. United States, Civil No. 153-61, in the United States District Court for the District of Utah, the plaintiff challenged the right of the United States to divert water from a spring on the National Forest and pipe it to a recreation area constructed by the Forest Service on national forest lands. This spring was tributary to a creek from which plaintiff had an appropriative right under a permit issued by the State of Utah to divert and use three acre feet of water per year for irrigation. The court in its decision dated March 16, 1963, found that the "recreation site and pipeline and diversion facilities constructed by the United States Forest Service were authorized by the Act of June 4, 1897, 30 Stat. 35" and that the United States had a right to make this use of these waters for recreational purposes "by reason of its reservation from entry on February 22, 1897, by the President of the United States."

And more recently, specifically in June of 1975, in the case of United States v. Alpine Land and Reservoir Co., No. D-183 BRT in the United States District Court for the District of Nevada, the court found that:

> Toiaybe National Forest was reserved and withdrawn from the public domain and dedicated and set apart as a national forest for the purpose of the protection of watersheds and the maintenance of favorable stream flows in and below the sheds; production of timber; production of forage for domestic animals, protection and propagation of wildlife, including fish, and recreation for the general public.

Before going to the discussion of the state decisions and by way of emphasizing their importance in the time to come, I would refer to the recent decision by the Supreme Court in the so-called Akin case. This decision was announced on March 24, 1976, and grows out of a water adjudication suit initiated by the United States in the Federal District Court of Colorado. That suit was for the adjudication of Indian, Forest Service and other federal water rights. The District Court dismissed the suit on the basis of the doctrine of abstention; the Court of Appeals for the Tenth Circuit reversed holding that abstention was not appropriate. The Supreme Court in a six to three decision held that dismissal could not be supported under any category of the doctrine of abstention, but went ahead to decide on principles of "wise judicial administration" that the judgment of the District Court dismissing the complaint should be affirmed.

The Akin decision gives great emphasis to the cases presently pending in state courts. It will afford the state courts additional opportunity to recognize federal reserved rights for instream uses.

2. Idaho Decisions.

In addition to these federal cases, there are certain decisions in the state courts which recognize federal instream flow rights. Probably the most striking of such recognition is here in the host State of Idaho where the District Court of the Sixth Judicial District has recognized that right and allowed the claim of the United States Forest Service to the entire natural flow of three streams for such use. That claim has been appealed by the State of Idaho to its Supreme Court and is currently under submission; it is Soderman v. Kackley; also sub nom Higginson v. United States Forest Service. In the interest of completeness on the Idaho scene, I should mention that there is another state district court holding in the Avondale case to the contrary.

3. New Mexico Decisions.

There are pending in New Mexico, two cases involving the question - one in federal court and one in state court. Both cases are pending before a Special Master. In the state case, Mimbres Valley Irrigation Co. v. Salopek, No. 6326 in the District Court of the 6th Judicial District, the Special Master has recognized water rights reserved by the United States for instream uses on the Gila National Forest. In the federal case, New Mexico v. Molybdenum Corp. the Special Master has taken the contrary view.

4. Colorado Decisions.

There was issued on April 16, 1976, the Master-Referee's Report in Water Divisions 4, 5, and 6, regarding the claims of the United States. This report deals in great detail with instream uses claimed particularly for the National Forests. The Master-Referee recognized the reserved right for minimum stream flows and, lake levels on National Forests but recommends a priority date no earlier than June 12, 1960 (the date of the Multiple Use Act). The Master-Referee provides for increases over the present instream uses on their quantification.

5. Washington Decisions.

Increased future uses but with a priority as of the date of creation of the particular forest was provided for in the decree of the Superior Court of the State of Washington In and For Okanogan County in the Chiliwist Creek adjudication. This decree recognizes the reserved right of the United States "to make use of the waters of Chiliwist Creek now and in the future in amounts reasonably necessary and sufficient to carry out the limited purposes for which the forest reserve lands were reserved; namely timber management and production and related purposes including fish and wildlife management, livestock grazing and recreational activities."

CONCLUSION

So much for the "legal" aspects of my presentation. Permit me a peroration that is part philosophizing, part prophesying and I hope, part wisdom. I think the country is blessed with two happy circumstances: (1) extensive federal ownership of lands and appurtenent water resources; and (2) the existence of a viable legal doctrine, by that

I mean the reserved rights doctrine, by which these lands and waters can be devoted in an orderly way to the purposes of recreation, fish and wildlife and purely asthetic or scenic enjoyment. I don't expect this audience or really any audience to jump up in an body and shout amen to either of these propositions. The extensive federal ownership of lands of our nation, particularly that in the western United States has been viewed with alarm by a lot of people for a lot of years. And even more so, the legal doctrine of reserved rights is the proverbial red flag before the bulls of various breeds.

Unquestionably federal ownership is substantial. I think the statistics as reviewed by the Public Land Law Review Commission in their 1970 report "One Third of the Nation's Land" are still substantially correct, at least as far as the lower 48 states. The colored map on p. 23 of their report shows Nevada to be the highest. It is colored green (a curious choice of colors for that desert state) which according to the key is from 80-100 percent federal ownership. Actually, 86 percent is the figure of federal ownership in the State of Nevada. Idaho and Utah are in the next category of 60-80 percent. Oregon, California, Arizona and Wyoming are 40-60 percent and Washington, Montana, Colorado, and New Mexico 20-40 percent.

The summary of the administration of these lands is worth noting in connection with our consideration. About one-fourth of the federal lands are administered by the Forest Service. Most of this is 160 million acres of public domain in the West; it also administers over 22 million acres of acquired national forest lands, primarily in the eastern United States and approximately 3.5 million acres of other acquired lands. Smaller acreages are managed by the National Park Service (from 23 million acres) and the Bureau of Sport Fisheries and Wildlife (over 26 million acres). The largest area of federal ownership is that administered by the Bureau of Land Management. But I want to talk mainly about reserved lands.

What this all comes down to is that either by accident or foresight or a combination of both, this nation by its federal ownership possesses a priceless treasure of undeveloped and unspoiled land; it possesses also a legal basis for supplying those lands with the water indispensable to their maintenance. My conclusion, therefore, is that by the judicious use of this legal doctrine, that is, the reserved rights doctrine, these areas of federal ownership can be administered so as to promote instream uses and the enjoyment of those areas by the public at large. This would be consistent, I suggest, with the general concensus that some part of our nation's water resources should be dedicated to instream uses.

FEDERAL RESERVED WATER RIGHTS FOR INSTREAM FLOWS AND FOREST SERVICE RESOURCE PLANNING

B. D. Turner, Jr.
Assistant Director for
Soil Conservation and Water Resources
Natural Resources Division
Office of the General Counsel
United States Department of Agriculture
Washington, DC 20250

It is a pleasure to be here with you today to speak on the topic of instream flows, or as the Forest Service prefers to call them, "resource maintenance flows." This is a subject which I consider to be one of the most important, as well as sensitive, issues in the field of State and Federal relations as to water rights. It is also a very important issue to the Forest Service of the Department of Agriculture inasmuch as many of the Forest Service's goals and objectives are dependent upon an adequate flow of water.

The Forest Service has for many years been in a continuing legal conflict with most of the western states on the issue of "reserve rights." Although the Service has traditionally made claims for both diversion and instream uses, it has not been until recently that the controversy has arisen around the instream claims.

In the last few years the public concern for the chemical, biological and physical integrity of the nation's waters, and the increasing need in recent years for a wide variety of purposes, including domestic use for administrative sites, irrigation of pastures, meeting recreation needs such as swimming and boating, sustaining fish and wildlife populations, grazing of livestock and many other purposes has made competition for the waters of the west more intense. It is estimated that competition will be even greater in the future. Therefore, with this awareness of a potential for damage to resource values or the drying up of streams, for whatever reason, I foresee a greater and greater need for the Forest Service to provide protection thereto.

Comprehensive land use plans must be developed for long term management of the national forests, with many of the management objectives requiring continuous, uninterrupted flows of water. Instream flows will be examined and requirements established, and where the reservation principle is applicable, water rights will be claimed under that doctrine. Where the reservation principle is not applicable, water rights will be obtained in accordance with state law. The Forest Service will endeavor to work cooperatively with the states in this endeavor, and it recognizes the need for the states to be informed as to present and future needs of water on the national forests.

It is the policy of the Forest Service that water required for national forest system purposes, including instream flows, will be used efficiently, and in water-scarce areas, it will be used frugally. Forest Service responsibility for meeting the water resource needs of the people dictates a policy of caution and reasonableness in the deliberate use of water to improve the use and productivity of the national forest system. In determining such water needs in areas of short supply, careful consideration will be given to the needs of non-national forest users who are dependent on water for their livelihood. This will require a Forest Service analysis of the importance of water, including instream flows, for national forest systems and non-national forest system purposes. The securing of favorable flows for off-forest users is one of the purposes of the national forests, but it must be balanced against the water needs to satisfy the other purposes for which the forests were established and are maintained. Required instream flows on forest land will not be diminished to satisfy the demands of a junior diverter who is wasting water.

Some purposes requiring instream flows include, but are not limited to, recreation, fish and wildlife, aesthetics, certain vegetative growth, and watershed protection and management. What will be the volume requirements? Those volumes of water in the reach of a stream necessary to serve the national forest purposes within the reservation.

We feel there are four areas of activities which dictate that instream flow determinations be made by the Forest Service. They are (1) adjudications; the Forest Service is subject to the general water adjudications in state court proceedings under 43 U.S.C. 666 (McCarran Amendment); (2) land use planning; comprehensive land use plans being developed or to be developed by the Forest Service will include allocations to uses that are dependent upon continuous, uninterrupted flows of water; (3) water development projects; the instream flows must be examined and requirements established whenever a diversion or impoundment threatens to alter these flows or levels; and (4) water resource planning by State and Federal agencies for which the amount of available unappropriated water must be known.

What is the basis for the United States' argument that under the reservation doctrine, the United States has the right to the use of the waters, both consumptive and instream, in an amount necessary for carrying out the purposes of the reservation? There has been a long history of agency management of the lands comprising the national forest system for purposes that require instream flows and maintenance of natural water levels. The 1902 Forest Service Manual, which was issued prior to the establishment of many of the national forests, recognized recreation as an important use of the lands. The Forest Service Use books issued in 1906, 1907 and 1908, and all subsequent Forest Service manuals provided guidance and regulation regarding the use of the national forests for purposes requiring instream flows and maintenance of the natural levels of water bodies. Various Chiefs' reports and studies of the resources requiring instream flows and maintenance of natural water levels, made during the very early years of the national forests, also provide further evidence of agency management of these resources. There is also considerable evidence regarding Congressional knowledge of and intent that the resources requiring instream flows and maintenance of natural water levels on the national forests, should be managed. The Act of October 1, 1890 (26 Stat. 650), provides one of the earliest records. It was this law that called for the establishment of forest reserves in California to preserve the natural wonders in their natural condition and to protect fish and game. The Organic Act (Organic Administration Act of 1897, 30 Stat. 34, as amended; 16 U.S.C. 473-478, 479-482, 551), provided further insight by requiring the establishment of regulations for occupancy and use of the lands comprising the national forests. The legislative history of the establishment of the White Mountain Forest contains substantial discussion regarding the recreational potential of the area. Not to be discounted are the Appropriation Acts throughout the years beginning in 1899 that provided money for the management of resources requiring instream flows and maintenance of natural water levels. A number of other Acts illustrate the interest Congress took in the multiple use management. Particularly noteworthy are: The Act of March 29, 1944 (58 Stat. 132); the Multiple Use Sustained Act, June 12, 1960 (74 Stat. 215), 16 U.S.C. 528-531; and the Wilderness Act (Act of September 3, 1964 (78 Stat. 890)), 16 U.S.C. 1131, 1136.

I would now like to give you a picture of the litigation scene that has developed, and is still developing, involving the Forest Service's claims for instream flows under the reservation doctrine.

The background basis for the Forest Service claims is laid in the United States Supreme Court decision in the case, Winters v. United States, 207 U.S. 564 (1908). This case established the authority of the Federal Government to reserve public lands, by withdrawing them from the public domain, and, thereby, reserving appurtenant unappropriated waters, exempting those waters from future appropriations. This doctrine was later recognized to extend to lands reserved for the national forest, as was indicated in the cases, Arizona v. California, 373 U.S. 546 (1963), and United States v. District Court for Eagle County, 401 U.S. 520 (1971). Unlike appropriative rights, these "reserved rights" are not lost by non-use, are not restricted by the limits of past use, and may be asserted to the extent necessary to meet future uses on the reservations. It is also the position of the United States that if a function or use of the reserved land, necessary to the purpose for which the reservation was made, requires complementary rights in waters beyond the boundaries of the reserved lands, but associated with them, then the United States may claim such rights as an extension of the prevailing reserved water rights. I should note that this last approach has been made only in the area of non-consumptive instream uses, and one which some states are strongly contesting.

Although the Supreme Court decisions I mentioned set forth the doctrines upon which the Forest Service bases their instream claims, finding acceptance of those claims in the various states has presented problems, many of which some of you may be familiar with. Obviously, the majority of cases arose in the western states, principally California, Colorado, Idaho, Nevada and New Mexico. Some states have recognized the instream, as well as the consumptive uses, as coming within the reservation doctrine. Others recognize the claims for consumptive use, but have held that the instream uses asserted were not within the purposes for which the forests were reserved, and, thus, not within the reservation doctrine's coverage.

Opposition to claims for instream uses has become almost a matter of course. In some past cases, the claims of the Forest Service for instream flows were upheld. In United States v. Alpine Land and Reservoir Co., et al., No. D-183 BRT, U.S.D.C., Nevada (June 27, 1975), the United States District Court for the State of Nevada recognized the instream use claims of the Forest Service in a case dealing with the Toijabe

National Forest. Addressing both consumptive and instream uses, the District Court spoke to current and reasonably foreseeable future uses. These reserved rights, which date from the time the forest was withdrawn from the public domain, were held to extend to waters adjacent to the forest.

Likewise, the Sixth Judicial District Court of Idaho found, in Soderman, et al. v. Kackley, et al., 6th Jud. Dist. Ct., Caribou Cty., Idaho, No. 1829 (April 14, 1975), that, as a matter of law, the Forest Service was entitled "to its claim of a non-consumptive use to the entire natural flow of the three streams in question from the point where they arise on the national forest boundaries to the point at which they leave the national forest boundary . . . since it (had) been shown that such use is required for the purposes for which the reservation was created." The Court recognized among the claimed uses: recreational uses by the public, fire fighting and prevention, protection and propagation of wildlife, preservation of fish cultures, and aesthetic and other public values. The Idaho Department of Water Resources has appealed this case to the Idaho Supreme Court.

Although the Forest Service's past attempts to gain recognition of the instream flow claims have met with some success, as indicated by the Alpine and Soderman cases, there have been setbacks for the Forest Service. Some state courts have favored the argument that the reservation doctrine extends only to the purposes of timber production and watershed management. This has been reflected in present litigation, as well as past. At present, my office has approximately 65 water rights adjudications pending in the western states. A few cases are illustrative of the opposition that is being made to the Forest Service's claims.

Again in Idaho, the First Judicial District Court, in Avondale Irrigation District, et al. v. North Idaho Properties, Inc., et al., No. 22418, 1st Jud. Dist. Cty., Kootenai Cty., Idaho (Dec. 1, 1975), denied the Service's instream flow claims, holding that the claimed non-consumptive uses were not within the purposes of the reservation. Rather, the District Court decided, the only purposes to which the reservation doctrine had application were the narrow uses of improvement and protection of the forest and the providing of water for appropriation in accordance with the state law. We have recommended to the Department of Justice that the District Court's decision be appealed to the Idaho Supreme Court.

The Forest Service claims have met with a similar fate, at least for the present, in New Mexico. On January 28, 1976, the Special Master issued his report to the United States District Court for New Mexico concerning the Red River adjudication, State of New Mexico, ex rel., S.E. Reynolds v. Molybdenum Corp. of America, et al., U.S.D.C., N. Mex., Civ. No. 9780. His report found that the only two purposes for which the Carson National Forest had been reserved were the protection of the watershed in order to ensure dependable water supplies for private users and the protection of the forest in order to secure a continuous supply of timber, such uses not requiring instream flows. Accordingly, the Special Master concluded that the Forest Service has no right to minimum instream flows in the waters of the Red River Stream system based upon the reservation doctrine. At this point a trial on the issues is contemplated for June 15 of this year.

In addition to the Red River adjudication, the Forest Service has another New Mexico case of interest: Mimbres Valley Irrigation Co. v. Solapek, et al., 6th Jud. Dist. Cty., Luna County, N. Mex., No. 6326. The Special Master in the case had recognized a right in the Forest Service to maintain minimum stream flows in three places on the Gila National Forest lands within the Mimbres River Watershed for fish management purposes. Upon objection by the State Engineer to the Report, the District Court sustained the objections and declined to adopt the Master's recognition of the right. A decision has not yet been rendered in the case, and comments of counsel to specific issues have been requested by the Court prior to issuance of an order.

Of more immediate interest is the present water rights adjudication being held in the 4th, 5th and 6th Water Divisions of Colorado. This adjudication, which began for the United States in 1967, has come to a point where a final decision is foreseeable.

The suit involves the claims for water by the United States based almost entirely upon the theory of reserved water rights. The water claimed relates to uses on national forests, national parks, national monuments, public springs and watering holes on federally-owned land, mineral hot springs, naval oil shale reserves, and Bureau of Reclamation projects. Within the three water divisions, there are seven national forests affected by the litigation. For each of these forests, the

United States has claimed rights for direct flow, storage, transportation and wells. Additionally, we have claimed the right to maintain continuous, uninterrupted flows and minimum stream and lake levels for waters within the forests. Regarding these instream flow claims, we argued that they are necessary to ensure the continued cultivation, conservation and reproduction of the fish which inhabit those waters, and to maintain appropriate aesthetic, scenic and recreational conditions on the forest lands. Our claims have asserted a priority-of-right date as of the date that each of the forests was reserved for forest purposes and withdrawn from the public domain.

The objectors opposing the claims of the Forest Service base their objections upon several theories: (1) that the reservation doctrine does not exist in Colorado and is, therefore, inapplicable; (2) that the purposes claimed by the Forest Service are beyond the scope of the original reservations; (3) that Colorado law should control the Federal reserved rights, if they exist; and (4) that as they concern certain of the objectors, the United States' claims are defeated by the doctrines of equitable estoppel and res judicata.

The long and tortuous journey of this adjudication may be approaching a culmination. The Special Master-Referee has issued a draft partial report and proposed decree. I will make the uninformed guess that the final report will be issued by the Special Master-Referee in the early weeks of May.

Conclusion

As you can see, the present situation that the Forest Service finds itself in, with regard to instream flows, is complex and constantly fluctuating. It looks as if we will be in a continuing legal battle on the issue of its reserved rights, unless there is legislation which would resolve this issue, or unless the United States Supreme Court would speak specifically to the matter.

Attempting to design and execute a nation-wide plan for water resource management is made even more difficult by the lack of consistency among the states in their respective recognition of the Forest Service's instream flow claims. However, I am able to say with confidence that the Department of Agriculture will continue to work with the states, in carrying out its responsibility of managing the national forests and the waters thereon in a manner that will not be detrimental to private and state rights. We will continue to furnish data setting forth the present and foreseeable uses on the national forests to the individual State Engineers.

INSTITUTIONAL AND POLICY ASPECTS OF INSTREAM FLOW NEEDS

Michael D. Bradley, Ph.D.
Department of Hydrology and Water Resources
University of Arizona
Tucson, Arizona 85721

ABSTRACT

Organizational doctrine and professional expertise are key determinants of water resources policy; traditional doctrine sees water to be abstracted, that is, taken and used, and engineering expertise physically expresses this doctrine. Instream flows are a new set of values, requiring institutional expression as a doctrine and individual value as a professional role. Institutional change to incorporate instream flow doctrine in policy will require conscious organizational learning.

INTRODUCTION

Although individual scientists study resource systems as part of the natural world, public decisions about the use of resources are made within institutions. What happens to natural resources is an institutional determination. Nowhere is this more clear than in the use of water resources; society uses water through institutions. Institutional roles range along a continuum from weak to strong and from ineffective to effective; nevertheless, institutional mechanisms are how we as a public intervene in the use of water resources, and understanding the institutional components of instream flow needs is vital.

Institutions are the way society intervenes in the use of water resources. The historical development of water resources in this country, as well as in other developed states and interstate regions, has been a pattern of institutional response to both the water allocation problems of the time and the available hydrologic technologies of water control. Although it is romantic and attractive to visualize an individual water user, such as an irrigator, in a one-to-one interaction with water, that vision is manifestly limited and unhelpful. It can lead to the erroneous assumption that an individual has significant extra-institutional choice in using his production factors, the most common example is the social myth of the entrepreneur in a free market economy. In fact, the irrigator is part of an institutional complex, some directly participated in and some not. His water and land rights are granted and defined by legislatures, courts, and other legal agencies. His crop markets, credit, and technical advice are all provided by organizations. His technology for working the land and for applying water comes from institutions, not to mention the intervention by one or more federal and state agencies to provide a long-term irrigation program, including dams, canals, structures, power, repayment schemes, and other economic incentives. In the modern world of rapidly urbanizing, highly technological, and increasingly organized society, the allocation of water resources is an institutional enterprise.

The institutional role in water allocation and use has not received the attention in the scholarly literature it deserves. In part, the reason is historic; until the rise of the organized state and attendant bureaucracies, water allocation could properly be perceived as only a market allocation of scarce resources, or as only an engineering enterprise to increase supply. Part of the reason is reluctance, we would rather not recognize the vast power of bureaucratic organization. Popular folklore is strongly anti-bureaucratic, in spite of the ever increasing societal reliance upon this form of modern enterprise. But the most important reason for ignoring water institutions is the fundamental difficulty inherent in studying organizations on a day-to-day basis; organizations are complex, multi-faulted, and difficult to understand. Past attempts at explaining institutional behavior focused upon the relationship between an organization and its environment (Simon, 1957). These relationships were easily measured and cast in objective terms, and survival could be linked to constituency satisfaction. More basically, organizations were studied as functional forms, as devices represented by charts with arrows that connect boxes, as entities that could be engineered for efficiency and effectiveness.

But organizational purpose is not as easily defined. Purpose includes elements of morality, equity, and justice, poorly measured values that are easily submerged by other measurable variables. Once structure and function were defined, then purpose could be found, or so went the myth. Unfortunately, purposes change rapidly, becoming old-fashioned and unresponsive nearly as fast as they are defined (Kaufman, 1975).

One reason institutions lag behind rapidly changing social purposes is the conservative buffering of external demands by administrative outlooks or professional ideologies. These suprainstitutional orientations are so pervasive that they are rarely examined as important determinants of public policy. Yet the attitude of decision-makers regarding water resources is a matter of ideology, acting as both an influence on organizational behavior and a constraint on administrative innovation. Fundamental to this view is the realization that decision-making and policy outcomes are a function of the decision-maker's perception. An organization's environment is filtered through institutional traditions and professional ideology, and too little attention has been given to examining the relationship between values and resulting policy outcomes. Such an assessment can supply insights into the development of water resources in this country and into the problems of expanding traditional ideologies and doctrines to include instream values in water resources planning and management.

THE FEDERAL DEVELOPMENT OF WATER RESOURCES

The federal government, based upon strong constitutional precedent, has played a dominant role in the development of water resources. Intervention in the use of water has generally taken the form of either direct construction of facilities or of licensing the regulated activities of others. In recent times, water quality programs have emphasized standard setting and state-regional regulation to assure compliance with water quality standards. A brief history of federal water programs can be developed by examining the major federal water resources legislation.

The federal government has played three dominant roles in the development of water resources: project developer, project licensor, and water quality regulator. Each is a function of federal water resources agencies, and has historically developed through the administrative history of the areas of operation.

Some federal agencies have traditional engineering missions and develop water resources within that charge. The Army Corps of Engineers, the Bureau of Reclamation, the Soil Conservation Service, and the Tennessee Valley Authority are the best known (Hillhouse, 1974). Several sources of constitutional power provide the federal government with authority to develop water resources, most notably the commerce power, the power to tax and spend for the general welfare, and the property power. The Supreme Court in Gibbons v. Ogden held that navigation was properly included in the Commerce Clause. The federal government also has clear authority for harbor and river development, flood control, and shore protection. The commerce power is sweeping enough to encompass projects for recreation, irrigation, and public water supply (Clark, 1967). The taxing and spending power of Congress is even less limited than the commerce power, as detailed in U.S. v. Gerlach Livestock Co.; Congress can tax and spend for the general welfare, limited only by the exercise of common benefit as opposed to merely local purpose. The property power deals with public lands and, by the implied reservation doctrine, public waters as well (Meyers, 1967). The limitations upon federal construction agencies are found in the project authorization-appropriation process (Ingram and Allee, 1972), the economic standards of project justification (WRC, 1972), a project's enabling legislation, and specific limiting legislation. Examples of limiting legislation are: the National Environmental Policy Act of 1969, the Rivers and Harbors Act of 1899, the National Park Service Organic Act of 1960, the Anadromous Fish Conservation Act of 1965, the Fish and Wildlife Coordination Act of 1943, and the Federal Water Project Recreation Act of 1970. The balance between enabling legislation and limiting legislation has changed drastically in an era of environmental concern, modifying projects and programs once thought inviolate by their agency supporters.

As a water project licensor, the federal government has directed the development of non-federal hydroelectric power by the Federal Power Commission; the licensing of nuclear power plants, particularly the use of cooling water; and the permit programs (of the Army Corps of Engineers) for construction in navigable waters. Under the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500), the federal government also regulates water quality by providing standards of allowable pollution and discharges into navigable water. A state permit system allows a stream's assimilative capacity to be used to dilute wastes and permits discharges up to the quality standard. This regulatory program is highly controversial, partly due to established waste treatment practices and partly due to the complex nature of standards resolution by permits (Zener, 1974).

The separation of federal action into two typologies, project developer and licensor, has its basis not only in history but also in economic geography of a watershed. Major river systems provide complex sets of economic goods and bads to local residents. Water is essential for all life processes and many productive enterprises; therefore, a distinction can be drawn between land uses and instream uses. Land uses include domestic supply, stock watering, municipal and industrial needs, irrigation, and the dilution of waste. Channel uses are derived from the flow of water; such as navigation, recreation, aesthetic pleasure, ecosystem maintenance, flood control, and waste abatement. Land uses require diversion, transportation, storage, and application facilities, usually constructed with public funds. High capital costs usually imply that the first major proprietor has a natural monopoly and is or should be subject to public regulation of process and services. Of more recent interest is the return flow from land use, which is often polluted or saline, a bad for downstream users. When such flows traverse national borders, complex international relations result and side payments to guarantee equitable utilization become necessary, regardless of expense (Utton, 1974; Lester, 1963; Israel and Zupkus, 1972; Witaschek, 1972; Dickstein, 1973; Brownell and Eaton, 1975; Handl, 1975).

Instream uses are even more difficult to manage and allocate than land uses. They are a pure common good that cannot be denied those gaining access. Even the benefits from flood control are not exclusionary, regardless of the inefficiency of this public allocation of funds (Haveman, 1972). On the other hand, navigation improvements can be reimbursed by users, as can licenses for using a stream's hydrologic gradient to produce electricity. Thus the yield of goods and bads from a stream is complex, ranging from marketable to purely public goods. The basic task of water resources administration is developing institutions to supply alternative uses under changing conditions of resource availability (Ostrom, 1968, 1971).

The history of federal water development is far too complex to adequately summarize here. Generally water policy in federal agencies has been a choice from a structured set of interventions in the private use of water with the purpose of providing water services to society (Craine, 1969). Intervention has several forms, some are relatively mild and seem innocuous, others represent broader exercises of public power, and are complex and controversial. A simplified scheme of public intervention in water use, starting with the mildest and leading to the most controversial is:

1) the provision of water resources intelligence, such as research, information, and education;
2) the integration of intelligence and information into systems of water resources planning;
3) the development of political and economic incentives to encourage compliance with planned policy, for example, subsidies to encourage certain water uses;
4) the regulation of direct or indirect uses of water, such as the water quality regulations prohibiting discharges based upon standards; and
5) the direct public management of entire service facilities or river basins to comprehensively optimize benefits to the public.

But public policy for water resources requires more than simply a set of intervention strategies or techniques. Effective water resources development also requires on-going planning and management of common property water resources. As federal interventions and programs increased over the past several decades, so has the level of professional commitment to water as an object of intellectual concern, and correspondingly, so have the institutional demands for water resources engineers, economists, planners, and administrators. Increased professional identity is often translated into the institutional role of water agencies, the agency doctrine that explains an organization's purpose. Agency doctrines have developed throughout the history of water resources development, and doctrines are important variables for understanding institutional roles in water development.

Doctrines are based on necessity and experience. Water development is a public action for relating objectives to programs in a systematic way, and for assessing costs and benefits in light of preferred outcomes. Difficult problems are encountered in this process. First, the theoretical recipient of the water development process, the public, has different value preferences resulting from different tastes and self-interests. One man likes to fish, another irrigates crops, a third enjoys boating or swimming. Different tastes and interests produce controversy, and seldom will all demands be resolved by a particular water management program.

Second, water management is technically complex, it involves questions of hydrology, engineering, law, economics, and design, to name only a few. Laymen rarely understand all the alternatives or consequences. But, choices cannot be left only to technical experts; knowing about water management does not mean one knows what is best for society. Third, in most situations many alternatives are conceivable. Alternatives need to be assessed by technical, economic, legal, and political criteria of feasiblity, and the assessment process demands scarce skills and resources. Fourth, water organizations need political support to survive. This encourages responding to the demands of a limited but responsive, narrow but supportive constituency interest; for water development agencies, strongest support has been from economic interests, such as irrigators and water shippers, instead of fishermen and recreationists. Identifying with a particular sector of society leads a water development agency to view as relevant only those alternatives consistent with the objectives of the supporting clientele. Finally, certain organization doctrines help agencies buffer and filter a complex and turbulent institutional environment, these doctrines are primarily models of how to structure serious programs of water development.

DOCTRINES OF FUNCTIONAL AGENCIES

Any evaluation of institutional performance is subjective. The assumptions and expectations of the evaluator influence his conclusions; furthermore, the evaluation is conditioned upon the passage of time, lessons learned recently cannot provide a fair basis for judging the institutional inadequacies of an earlier time. If evaluated in relation to the past, an institution's performance might be considered good, whereas in relation to current problems the same performance might be inadequate. Therefore, differing assessments may all be correct, given the time frame of reference (Caldwell, 1975). It is important to understand institutional doctrines against the time frame in which they were developed.

Three fundamental doctrines guided the development of water resources by federal and state functional agencies: the doctrine of engineering supply, the necessity of geographic rationality, and the assumption of limited value change in society. Each explains an entire method of perceiving and understanding the complexities of water resources use, and each developed in conjunction with the other. Separating the doctrines into three is arbitrary, but the value of this analysis is in explaining institutional patterns of perception, and consequently institutional behavior.

The Doctrine of Supply Engineering

A fundamental organizational doctrine is that of supply engineering, basically this doctrine assumes that water resources development is only a matter of supply and that more water solves most water problems, especially scarcities, shortages, or inefficient allocations. The supply solution is an engineering doctrine, in fact most engineering schools and curricula contain specific courses on water supply engineering, and many texts contain some derivative of that idea as a title. The supply doctrine is the explanation of what the construction agencies of the federal government have as a mission (the Army Corps of Engineers, the Bureau of Reclamation, the Soil Conservation Service, and the Tennessee Valley Authority). It also is the doctrine of most local water supply agencies, especially urban institutions. Water supply engineering deals with more than just shortages, water abundance in the hydrologic cycle can lead to destructive floods. Both problems can be "solved" by structures such as dams and levees, and by storing floodwaters in reservoirs to provide supply during the low flow seasons. Multiple purpose benefits can then be assigned to beneficiaries, making construction even more likely.

The Doctrine of Geographic Rationality

The second important organizational doctrine is geographic rationality. This doctrine is not identified solely with the engineering disciplines, instead it is a term for planning the economic-geographic opportunities of a watershed by rationalizing the physical-biologic opportunities for water use, by capturing economies of scale in development, and by internalizing diseconomies of externalities. Geographic rationality implies an organization with sufficient jurisdiction to encompass an entire drainage basin or catchment and sufficient policy-making power to intervene by the strategies previously mentioned (Roberts, 1968; Roberts, 1971). The American experience with river basin management has been slow to effectively prove the basic tenants of this doctrine (Ingram, 1973; Selznick, 1949). Recent methodology development may overcome technical difficulties in economic analysis, if not political resistances (WRC, 1973; Hanke, 1973).

The Doctrine of Limited Change

The final organizational doctrine important for water resources management is limited change. Until recently, water planning operated in a perceived institutional environment that was benign and stable. Water resources could be allocated among the most powerful and articulate contenders for benefits with everyone enjoying a constantly increasing economic output. Conflicts could be resolved without painful allocation because even the losers were much better off than before. In this situation, measurable economic benefits were granted first priority and interest, and the unmeasured costs of consequences to society or of damages to natural ecosystems remained unmeasured, and thus unimportant.

Although doctrines are helpful for understanding institutional behavior, they are not in themselves an adequate explanation of decision-making with all its manifest ramifications. But, doctrines do provide a first step in understanding recurrent patterns of planning and policy-making over time. Once the world view of actors in the political-administrative processes is appreciated, it becomes easier to understand why certain alternatives are considered and not others (engineering structures but not land-use zoning), why certain costs are calculated but not others (direct construction costs but not second-order, non-reimbursible effects), and why certain patterns of organizational change are anticipated but not others (increasing the domain of professional alternatives to include "new" problems, but not considering turbulence in organizational goals). Doctrines also establish the domains of agency expertise, a civil engineer in one agency would concentrate solely upon water development projects, while the same engineer in a different organizational context might work with the engineering problems of soils or with housing development. Expertise influences public policy by giving experts the role of advisors and by granting experts discretion in determining the important. Both of these roles are sharpened and focused by an agency doctrine detailing the goals and purposes, the agency's mission. Doctrine thus serves as an internal check upon arbitrary use of power, and makes organizations more conservative and less likely to change. If existing doctrines comfort an agencies experts by conforming to their own professional view of problems and solutions, then resistance to changed perceptions will buffer against any alteration in policy (Rourke, 1969).

The integrating role of professional doctrines upon institutional behavior has long been recognized but rarely studied. Professionals sharing the same professional and agency doctrines offer a stronger resistance to change brought on by uncertainties of a turbulent environment. Particular ways of doing things shape the way public policies evolve; actor self-images are as important to understanding the administrative process as authorizations and budgets. The role of professional doctrine and agency policy has been clearly examined for foresters, range and wildlife managers, and soil conservation professionals (Schiff,1966). Those insights help explain why engineering agencies approach problems of water pollution as a problem of competing uses, and of allocating a river's "assimilative capacity" to meet certain goals, and why ecologists and biological scientists seek the restoration and maintenance of the physical, chemical, and biological integrity of a waterway itself. Ecologists assume that if the "balance of nature," approaching natural purity is restored and maintained, the water will be clean enough for all man's uses while meeting ecosystem maintenance and aesthetic goals (Westman, 1970). Contrasting approaches to problems reveal basic differences in professional and agency doctrines. Although interdisciplinary coordination is necessary, some irreversibilities and long-run ecological values are simply not coordinable; integration then becomes necessary, especially multi-value integration for more responsive water resources policy (Fisher and Krutilla, 1974). Integration is costly in its own way, and requires a holistic awareness of environmental relationships. Institutional integration is particularly difficult; it requires changed images of reality, sensing problems in a new way and adjusting policy to cope with previously unappreciated factors (Caldwell, 1975).

INSTREAM VALUES AND INSTITUTIONAL CHANGE

Many factors account for the recent change in what is considered acceptable water resources policy. Among these are: shifts in public perceptions about governmental responsibilities; a turbulent economy allocating goods and services in a seemingly inequitable manner; new technologies with significant impacts; and rising expectations about the required level and appropriate distribution of public goods and services (Susskind, 1974). These conditions have created organizational environments for traditional agencies that can only be called turbulent, disruptive, and unstable. Old constituencies have flown apart, old methods no longer produce the desired result, old doctrines no longer reflect reality. Instead, new demands are voiced, often by those unheard or ignored before; new standards are accepted for defining both "problem" and "solution;" and new decision rules change the output of water resources agencies.

A fundamental source for turbulence and uncertainty in the environment of public agencies is the rapidly accelerating concern with deterioration in the quality of American life. These matters are not only moral and philosophic; environmental quality is a fundamental and frustrating conflict in the social choices made by present economic and political institutions. The conflict is between those who prefer to continue as in the past and those who recognize the range and depth of the public demand for environmental quality. Instream values of water flows are part of this new demand, an expression of "biopolitics" (Caldwell, 1968). The word describes political reconciliation of biological facts and social values -- notably ethical values -- in the formulation of public policy. It also suggests changed rules for water resources decision-making.

Current indications are that old decision rules no longer apply individually as they once did, new purposes and doctrines require a different code. Water resources development was traditionally a matter of building local projects answering strictly local needs, including the "needs" of congressmen for tangible evidences of constituency reward, and the "needs" of local economic interests for contracts, payrolls, expanded markets, and growth. However, this first decision rule has abruptly changed. Local support for projects is often undermined by the realization of second-order consequences and of externalities that will need to be internalized at local expense. Development is often a liability, not a success; it brings congestion, pollution and problems, instead of happiness. Local economic growth is no longer automatically equated with progress and a higher quality of life. The second changed decision rule is basic goals agreement. Once the congressional authorization process of committee meetings and public hearings served to enforce broadly accepted economic goals. Now, water developers face conflict, controversy, and often, opposition. Environmental interests are more articulate, and have surprising success in court cases reviewing large projects (Anderson, 1973). Projects are easier to block, for reasons that relate to none of the traditional concerns of construction or application programs. The third changed decision rule is non-interference and mutual accommodation. Once decision-making was a closed process, with projects strung together to broaden support for the whole package. Project backers built support by accommodating and log-rolling, by going along with another's project so he'd support yours. Today, lack of agreement about basic goals means that it is impossible to satisfy all participants; not all aspire to growth and development through water project construction. Construction agencies do not satisfy environmental interests by pouring concrete for large projects (Ingram, 1972). Organizational doctrines are subject to rapidly increasing pressure for change, caused by first the almost universal problem of local beneficiaries and greater than local costs, and second, by the dilemma that accommodating all interests into an economic payoff tends to increase the likelihood of even more turbulence, uncertainty, and disruption in the institutional environment of water resource development.

Already changed decision rules have appeared in public legislation and in court decisions. The most famous legislative expression is the National Environmental Policy Act of 1969 (Pub.Law 91-190), and the most famous cases are those interpreting and shaping the Act's application. Courts are insisting that agencies undergo procedural change when writing EIS's on projects, and are also defining substantive changes in acceptable decision-making based on those statements (Anderson, 1973). The idea of assessment and environmentally sensitive policy-making is finding more recent expression in a new generation of legislation; notably the Forest and Range Renewable Resources Planning Act of 1974 (Pub.Law 93-378), The Technology Assessment Act of 1972 (Pub.Law 92-484), and other proposals. Overall, the "new" concern with instream values is part of an increased awareness of the purposes of public action being translated, often hesitantly and always painfully, into public policy.

CONCLUSION: TOWARD THE LONG-RANGE FUTURE

If instream concerns are only part of a much larger process in present water resources policy, what can be said about the overall, about what it means, and where things are going? First, it seems clear that future water policy will be fundamentally different from past policy. Societal change occurs rapidly today, and the pace of change appears to be accelerating. Policy that provides for past constituency interests, with outcomes appropriate for an earlier time , legitimized by methods which detail the quantities no longer important is sure to fail. It is now necessary to face the future and plan water resources in ways responsive to environmental uncertainty, turbulence, and disruption.

Second, increased social complexity means more responsibility for the public sector; for more public goods provided by constitutional choice, for more public management, and for more planning to rationally allocate the common property resources of mankind: water, air, wildlife, wildlands, and so on. The problems of uncertainty, turmoil, and scarcity are undermining traditional resource planning ideas and methods. Not long ago systems science, planning-programming-budget systems, management information science, and bigger, more sophisticated computers were to overcome environmental problems and efficiently allocate natural resources. Not long ago planning themes were consensus, comprehensiveness, rationality, and order; today the problems are diversity, conflict, division, and tension. Resources planners now more than ever need to plan for increased future consumption and conservation of the common property heritage of mankind. Adequate planning requires more than just scientific information, more than just market economics, and more than just technical or engineering efficiency. Resources planning can no longer respond to the turbulent and uncertain problems of a disruptive future with the social myths of the cowboy economy, the stable society, and the expansionist ethic of an era now closed.

As yet, no adequate theory of long-range planning exists. It will undoubtedly require overcoming individual and institutional resistance to change. It will require institutions that provide choices for allocating common property resources, not just market transactions. It will require planning for the biosphere's processes and limits, not just man's technological schemes (Vickers, 1968).

But anticipating options, boundaries, and choices is a new, untested role for most water planners, one requiring not only different skills and knowledge, but also personal incentives for changing toward future-responsive planning (Michael, 1973). The task has three parts: one is maintaining the life support system of human and general ecosystems; another is assessing the future consequences of present policy and actions, including the full range of problems and impacts; and the last is developing plans that integrate the value considerations of resources use with the objective or quantified components. Unfortunately, present methods focus upon quantified indicators; upon multiobjective, multicriterion considerations; and upon the easier part of the planning equation (Utah State University, 1974). Multivalued choices are still left to chance, and are still largely outside formal planning processes. Yet these are the most fundamental issues of all, and ignoring them will be less and less acceptable in a turbulent, uncertain future.

Finally, water resource planning and policy-making will have to be more carefully concerned with the problems and opportunities of feedback. Feedback is a crucial component of organizational evaluation, containing information upon where to change agency doctrines and goals as well as clues about why to change (Kaufman, 1975). In the past, water institutions developed elaborate mechanisms to filter feedback, to adjust it to prevailing agency doctrine and to ignore it, if possible. Much of the current interest in public participation has unfortunate connotations; it assumes the public can be educated to an agency's goals-doctrines, and harmlessly co-opted into a ritualistic advisory process (Mazmanian and Lee, 1975). Such a tactic would work much better in a stable organizational environment than it is likely to in the forseeable future (Selznick, 1965). Other responses to unwelcome feedback include denial, "nothing is really different;" flight, "other agencies don't suffer with this, so I'll go there;" and forecasting, "extrapolation is better than nothing, especially uncertainty." What is needed is to channel these responses into a learning system whereby agencies use a reiterative relationship to respond and adapt to an environment in flux.

Making water resources agencies learn better is easy to say, and undoubtedly difficult to accomplish. It will require different professional roles on the part of those with value-linkages important for agencies to incorporate. New roles would include boundary-spanners between an environment and institutional technical personnel (Michael, 1973; Thompson, 1967). Also important are roles for organizational development, helping an institution restructure its capability to deal with social turbulence, and for transactive planning, helping institutions link knowledge to policy action by learning (Michael, 1973; Friedmann, 1973). But, by far the most important role is for those who can combine social values into a vision, a controlling synthesis of where society is and wants to be (Morison, 1974). Vickers calls this an "appreciation" (1968). Whatever its name, it deals with the multivalue planning of the acceptable, eventual outcomes of public policy. A knowledge of the capabilities and limitations of water institutions will be necessary for both the future study and practice of water resources administration.

REFERENCES

Anderson, Fredrick R., Jr., NEPA in the Courts: A Legal Analysis of the National Environmental Policy Act. (Baltimore: The Johns Hopkins University Press, 1973).

Brownell, H. and Eaton, S. D., "The Colorado River Salinity Problem with Mexico," Amer. J. Int. Law, 69(2) 1975: 255-271.

Caldwell, Lynton K., "Biopolitics: Science, Ethics and Public Policy," Yale Rev., LIV(1) 1964: 1-12.

Caldwell, Lynton K., Man and His Environment: Policy and Administration. (New York: Harper and Row, 1975).

Clark, Robert E. (ed.-in-chief), Waters and Water Rights, 6 Vols. (Indianapolis, Indiana: The Allen Smith Company, Publishers, 1967).

Craine, Lyle C., Water Management Innovations in England. (Baltimore: The Johns Hopkins University Press, 1969).

Dickstein, H. L., "International Lake and River Pollution Control: Questions of Method," Columbia J. Transnational Law, 12(3) 1973: 487-519.

Federal Water Pollution Control Act Amendments of 1972, Pub. Law 92-500, 86 Stat. 816.

Forest and Range Resources Planning Act of 1974, Pub. Law 93-378, 88 Stat. 476.

Fisher, Anthony C. and Krutilla, John V., "Valuing Long Run Ecological Consequences and Irreversibilities," J. Envir. Econ. and Mgmt., 1(2) 1974: 96-108.

Friedmann, John, Retracking America: A Theory of Transactive Planning. (New York: Anchor Press/Doubleday, 1973).

Gibbons v. Ogden, 22 U.S. (9 Wheat)1(1824).

Handl, Gunter, "Territorial Sovereignty and the Problem of Transnational Pollution," Amer. J. Int. Law, 69(1) 1975: 50-76.

Hanke, Steve H. and Walker, Richard A., "Benefit-Cost Analysis Reconsidered: An Evaluation of the Mid-State Project," Wat. Resources Res., 10(5) 1974: 898-908.

Haveman, Robert H., The Economic Performance of Public Investments: An Ex-Post Evaluation of Water Resources Investments. (Baltimore: The Johns Hopkins University Press, 1972).

Hillhouse, William A., II, "The Federal Law of Water Resources Development," Federal Environmental Law, (eds.) E. L. Dolgin and T. G. P. Guilbert (St. Paul, Minnesota: West Publishing Co., 1974): 844-926.

Ingram, Helen M, "The Changing Decision Rules in the Politics of Water Development," Wat. Resources Bull., 8(6) 1972: 1177-1188.

Ingram, Helen M., "The Political Economy of Regional Water Institutions," Am. J. Ag. Econ., 55(1) 1973: 10-17.

Ingram, Helen M. and Allee, David J., The Authorizations and Appropriations Processes in Water Resources Development: A Report to the National Water Commission. (Springfield, Virginia: National Technical Information Service, 1972).

Israel, Robert and Zupkus, Robert, "Model Statute: International Drainage Basin Pollution Control," Denver J. Int. Law and Policy, 2(1) 1972: 89-106.

Kaufman, Herbert, "The Natural History of Human Organizations," Admin. and Soc., 7(2) 1975: 131-149.

Lester, A. P., "River Pollution in International Law," Amer. J. Int. Law, 57(6) 1963: 828-853.

Mazmanian, Daniel A. and Lee, Mordecai, "Tradition Be Damned! The Army Corps of Engineers Is Changing," Pub. Admin. Rev., 35(2) 1975: 166-172.

Meyers, Charles J., "The Colorado River," Stan. Law Rev., 19(1) 1966: 1-75.

Michael, Donald N., On Learning to Plan - and Planning to Learn. (San Francisco, California: Jossey-Bass Publishers, Inc., 1973).

Morison, Elting, E., From Know-How to Nowhere: The Development of American Technology. (New York: Basic Books, Inc., Publishers, 1974).

National Environmental Policy Act of 1969, Pub. Law 91-190, 83 Stat. 852.

Ostrom, Vincent, "Water Resources Development: Some Problems in Economic and Political Analysis of Public Policy," Political Science and Public Policy, (ed.) A. Ranney. (Chicago, Illinois: Markham Publishing Co., 1968): 123-150.

Ostrom, Vincent, "Public Choice: A Different Approach to the Study of Public Policy," Pub. Admin. Rev., 31(2) 1971: 203-216.

Roberts, Marc J., "River Basin Authorities: A National Solution to Water Pollution," Harv. Law Rev., 83(8) 1972: 1527-1556.

Roberts, Marc J., "Organizing Water Pollution Control: The Scope and Structure of River Basin Authorities," Public Policy, 19(1971): 75-141.

Rourke, Francis E., Bureaucracy, Politics, and Public Policy. (Boston, Massachusetts: Little, Brown and Company, 1969).

Schiff, Ashley, "Innovation and Administrative Decision Making: The Conservation of Land Resources," Adm. Sci. Quar., 11(1) 1966: 1-30.

Selznick, Philip, The TVA and the Grass Roots. (Berkeley and Los Angeles, California: University of California Press, 1949).

Simon, Herbert A., Administrative Behavior. (New York: The Free Press, 1957).

Susskind, Lawrence E., "The Future of the Planning Profession," Planning in America: Learning From Turbulence. (ed.) D. R. Godschalk. (Washington, D.C.: American Institute of Planners, 1974): 138-160.

Technology Assessment Act of 1972, Pub. Law 92-484, 86 Stat. 797.

Thompson, James D., "Social Interdependence, The Policy, and Public Administration," Admin. and Soc., 6(1) 1974: 3-20.

U. S. v. Gerlach, 399 U.S. 725 (1950).

Utah State University, Water Resources Planning, Social Goals, and Indicators: Methological Development and Empirical Test. (Logan, Utah: Utah Water Research Laboratory, 1974).

Utton, Albert, "International Water Quality Law," International Environmental Law. (eds.) L. A. Teclaff and A. E. Utton. (New York: Praeger Publishers, Inc., 1974): 154-186.

Vickers, Sir Geoffrey, "The Multi-Valued Choice," Value Systems and Social Process. (New York: Basic Books, Inc., 1968): 112-132.

Water Resources Council, "Principals and Standards for Planning Water and Related Land Resources," Fed. Reg., 38, Part II (1973): 24777-24869.

Westman, Walter E., "Some Basic Issues in Water Pollution Control Legislation," American Scientist, 60(2) 1972: 767-773.

Witaschek, Fred V., "International Control of River Pollution," Denver J. Int. Law and Policy, 2(1) 1972: 35-54.

Zener, Robert, "The Federal Law of Water Pollution Control," Federal Environmental Law. (eds.) E. L. Dolgin and T. G. P. Guilbert. (St. Paul, Minnesota: West Publishing Co., 1974): 682-791.

INSTREAM FLOWS--THE BIG PICTURE

Keith Bayha[1]
Fish and Wildlife Service
Washington, DC 20240

ABSTRACT

This paper deals with efforts to appraise the relative adequacy of our Nation's water supplies in meeting our present and future needs. Preliminary analysis of data developed as part of the 1975 National Water Assessment indicates severe conflict between instream and offstream uses of water in the western states and in southern Florida. This conflict is projected to become more extensive and intense in the future due primarily to expansion or irrigated agriculture to meet demands of international markets.

Criteria from the "Montana Method" is used to help paint the big picture regarding the future of instream values. This picture indicates the need for a major new thrust in providing substantive instream flow input into the decision making process regarding allocation of this Nation's water resources and our investment therein.

INTRODUCTION

A substantive study of instream flow requirements should be conducted in the field on the stream reach in question. An analysis of the collective water requirements of a group of streams comprising a major river basin cannot be made without some sacrifice in precision.

The 1975 National Assessment of Water and Related Land currently being conducted by the Water Resources Council is an effort to develop an appraisal of the adequacy of our Nation's water supply in meeting our present and future needs. This study includes the first Nationwide examination of instream flow requirements and the implications of accelerated offstream uses of water.

The findings reported here are preliminary in as much as the Assessment is not scheduled for completion until 1977. The interpretations and conclusions are mine alone and are offered here to illustrate the "Big Picture" relative to pressures on instream flow values now and in the near future.

To many of you, the subject of instream flows may seem to be a relatively new component of water planning and implementation. Actually biologists have been concerned about instream flows as far back as the 1940's. But it was not

[1]Fish and Wildlife Biologist for the U.S. Fish and Wildlife Service on detail to the Office of the Assistant Secretary for Land and Water to serve as Interior Coordinator for the 1975 National Assessment of Land and Water Resources.

until the "Environmental Age" of the 1970's when new legislation and vocal public concern provided the leverage needed for the biologists' views to be seriously sought by the water planning community. And when it did happen, it occurred with such suddenness that with few exceptions the biologists were not prepared to respond. To develop the needed response, large amounts of money and manpower were required and in some cases more time than was acceptable. Decisions have been and unfortunately will continue to be made with less than totally adequate information regarding the impact on instream values.

To document the condition in 1975 with respect to where instream flow studies had been conducted and where the need for input on instream flow requirements was most acute, I polled the field personnel of the U.S. Fish and Wildlife Service's Division of Ecological Services. Their collective response is illustrated on Figures 1 and 2. Figure 1 shows the concentration of completed and current instream flow studies in the western States. Figure 2 shows the relative constraint that lack of instream flow data is imposing on sound water planning activity, in the opinion of the contacted FWS field personnel. Again the pressure is mainly in the west, but significant pressures are evident in certain eastern locations.

With this picture in mind, let us return to the National Assessment and examine our efforts to quantify the relationship of instream flow needs with offstream uses of water.

In developing the Plan of Study for the 1975 National Water Assessment, a volumetric analysis of the consumptive and nonconsumptive water requirements in relation to the water supply was conceived using 106 Aggregated Sub-areas (hereinafter referred to as ASAs) as the basic geographic accounting units (Figure 3). These ASAs are approximations of river basins or groups of river basins as shown in Figure 3a. As input to this analysis a set of numbers were needed to represent the instream flow requirements. The U.S. Fish and Wildlife Service drew the assignment to develop these numbers.

This was a traumatic experience. First of all, describing instream needs at the outflow point of an area as large as an ASA is biologically unsound. Secondly, for much of the country there were almost no satisfactory biological data with which to correlate hydrological data. Furthermore, the state-of-the-art was not readily available. However, the options were few and the choice clear. We could

1) Refuse to quantify the instream flow needs, because of lack of sound data, and the risk of understating the situation (due to

the coarseness of the analytic unit), and by default allow the instream flow need to be considered zero; or

2) We could develop approximations of the instream flow requirement based on our judgment and the best information we could find and thereby assure the instream flow values would be considered in the analysis.

We opted for the latter on the grounds that this Level A study is aimed not at making final decisions on use of our water resources, but at identifying problems requiring additional attention by the water planning community.

To this end, we concluded that in setting the Instream Flow Approximations[2] (the term coined purposely to identify the numbers developed for use only in the National Water Assessment) we would accept the error of indicating a conflict between instream and offstream uses of water when in truth it would not occur; but we would not accept the error of failing to identify a conflict when in truth it would occur. Therefore our assumptions are consistently conservative on the side of identifying more water for instream uses than further study might reveal to be justified. In some cases they may be expressions of "wants" as opposed to "needs."

METHODS

Instream Flow Approximations

The Instream Flow Approximations were developed by a team of FWS biologists using the USGS Water Supply Statistics[3] and a variety of methodologies and references. Figure 4 indicates which approach was applied for the various parts of the country. A narrative description of the resources and factors considered was proposed for each of the 21 Water Resources Council regions. The IFA data consisted of an annual and twelve monthly figures stated in CFS for each of the 106 ASAs. Subsequent to review of this February 1975 product some of the IFA data were revised to reflect changes made in the basic water supply data.

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[2]Instream Flow Approximation is defined as a flow regime, consisting of quantitative expressions of judgmental estimates of monthly flows at the outflow point of a basin (ASA), sufficient to support the habitat of aquatic life forms and outdoor recreation; solely as input to the Environmental Alternative Policy Run of the agricultural assessment being made by the Agricultural Resource Assessment System Technical Committee, and the volumetric analysis being made by the Water Resources Council as part of the 1975 National Water Assessment.

[3]The USGS Water Supply Statistics for the 1975 National Water Assessment include depletions at near 1975 level of development and also reflect operation of reservoir storage as it would be detected by USGS discharge recording stations.

Volumetric Analysis

Water requirements for eleven functional uses were developed by Federal agencies for each ASA for 1975, 1985 and 2000. The consumption related to these requirements is a key element in the Volumetric Analysis. In addition, evaporation from man-made reservoirs, imports and exports, and groundwater use were also factored into the analysis. On the water supply side, USGS provided data on surface water and groundwater. These data were computerized and printed in a series of tables. Time will not permit a full explanation of all the inputs, outputs, and the data manipulation involved in this analysis. However, a written explanation prepared by the WRC staff is included as Appendix A.

The objective of this analysis was to obtain a relative indicator of the degree to which the Nation's streams are currently depleted and will be further depleted in the future because of current and future levels of consumptive use.

It should be especially noted that the comparisons presented are not for an ASA; rather they are made for specific points on the Nation's stream system. For example, the comparisons displayed for the outflow point of ASA 1011 do not provide indicators for what would happen in ASA 1011; rather they provide an indication of what would happen to streamflow conditions at that point due to the collective changes in consumptive use, in all upstream ASAs in the Missouri Region (Figures 3 and 5).

Similarly, the analysis at the outflow point of ASA 803 represents the effects of the collective changes in the Arkansas-Red-White, Missouri, upper Mississippi, Ohio, Tennessee and lower Mississippi Regions.

In the coastal ASAs there are often several rivers flowing into the ocean and, therefore, the comparisons are not for a point; rather they represent a gross estimate of the overall effect of collective changes in consumptive use on that group of streams entering the ocean. In the closed basins they represent what is happening within the one or more watersheds comprising that ASA upstream from the terminal lakes or sinks.

The Great Lakes are treated as if they were the sea with only the U.S. watershed assumed as the supply. In the lower Rio Grande and Souris-Red-Rainy only the U.S. portion of the watershed was included.

Criteria

Direct comparison of the Instream Flow Approximations with the Present and Future Modified Flow indicates, to a degree, where conflicts may exist. However, because the Instream Flow approximations were developed prior to the volumetric analysis and only indirectly reflect the impacts of past water use, it was felt that a second criterion was needed to judge the relative impact of the projections for consumptive water use on the fluvial ecosystems.

The Montana Method (Tennant, 1975)[4] offered criteria which could be adopted for use in the columetric analysis. Tennant's 60, 30 and 10 percent of mean annual flow provide the basis for describing the severity of impact. However, the significant development of storage, transbasin diversion and the use of groundwater in many ASAs required that a surrogate for the mean annual flow be developed. This surrogate is the "Natural Modified Flow" (NMF), which is the estimated stream flow in the natural state with present conditions of storage and operation, at the principal point(s) of discharge from the ASA.

$$NMF = PMF + \Sigma(USE_p + EV_p + E_p - I_p)$$

where PMF is the flow determined by USGS to exist with 1975 level of development. This flow is given for the mean water conditions and the dry year conditions (95 percent probability of being exceeded as a mean).

$\Sigma(USE_p + EV_p + E_p - I_p)$ is the summation of current depletions from NMF for a given ASA and all upstream ASAs as previously described.

USE_p is the actual water consumption calculated for 1975 (which is somewhat less than 1975 consumption demand).

EV_p is present reservoir evaporation.

E_p is present total export.

I_p is present total import.

A whole family of ratios were computed, but for the sake of simplicity, only the RR2 ratio is used in the data presented here. This ratio expresses consumptive water requirements, evaporation, exports, import consumption as a percentage of the Natural Modified Flow in the following manner:

$$RR2 = \frac{\Sigma(C_f + EV_f + E_f - IC_f)}{NMF} = \frac{\Sigma(C_f + EV_f + E_f - IC_f)}{PMF + \Sigma(USE_p + EV_p + E_p - I_p)}$$

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[4]Donald L. Tennant. 1975.
Instream Flow Regimens for Fish, Wildlife, Recreation and Related Environmental Resources. U.S. Fish and Wildlife Service, Billings, Mont. 30 pp.

where C_f is total consumption demand in the appropriate future target year.

EV_f is future reservoir evaporation.

E_f is future total export.

IC_f is that portion of future imports consumptively used.

(To calculate 1975 depletion ratio, we would use present values in the numerator.)

In most cases RR2 is the most accurate representation of the actual depletion in the area. Export in particular is a consumptive use which is invariably satisfied from surface water sources. Therefore, to reconstruct the historic flow the amount of this export should be added back to the flow. Similarly, some of the present flow in the stream is due to imported waters and these imports should be subtracted out of the flow. In the numerator the surface water demand is estimated as the sum of the consumptive, evaporative and export requirements minus the estimated amount of requirement satisfied by the imports.

Regarding groundwater, there is an implicit assumption that groundwater and surface water are interdependent and are treated as one water supply in the RR2 ratio. This is usually the case. Where this is not so, we have an RR3 ratio which deals with this situation. I will not go into this ratio here since I am presenting no RR3 data. However, the parameter is discussed in the aforementioned appendix.

Thus, the Natural Modified Flow provides a more consistent base than the mean annual flow of record for computing the relative depletions (RR2 ratios). This allows us to compare

1) Future depletion levels (or conversely instream flow conditions) with present depletion levels; and
2) Relative depletions among ASAs.

By subtracting Tennant's percentage criteria (which relate to the conditions in the stream channel) from unity, we have an expression of the complementary depletion level (description of the offstream use) which can be compared to the present and future conditions. Thus:

60 percent mean annual flow = 40 percent depletion of NMF

30 percent mean annual flow = 70 percent depletion of NMF

10 percent mean annual flow = 90 percent depletion of NMF

The following quotations from Tennant (1975) describe the instream conditions for each of these benchmark flow conditions.

"Sixty percent (60%) of the average flow (Fig. 6): This is a base flow recommended to provide excellent to outstanding habitat for most aquatic life forms during their primary periods of growth and for the majority of recreational uses. Channel widths, depths, and velocities will provide excellent aquatic habitat (Fig. 1). Most of the normal channel substrate will be covered with water, including many shallow riffle and shoal areas. Side channels that normally carry water will have adequate flows. Few gravel bars will be exposed, and the majority of islands will serve as wildlife nesting, denning, nursery, and refuge habitat. The majority of streambanks will provide cover for fish and safe denning areas for wildlife. Most pools, runs, and riffles will be adequately covered with water and provide excellent feeding and nursery habitat for fishes. Riparian vegetation will have plenty of water. Fish migration is no problem in any riffle areas. Water temperatures are not expected to become limiting in any reach of the stream. Invertebrate life forms should be varied and abundant. Water quality and quantity should be excellent for fishing and floating canoes, rafts, and larger boats, and general recreation (stream with an average flow in excess of 100 cfs). Stream esthetics and natural beauty will be excellent to outstanding."

"Thirty percent (30%) of the average flow (Fig. 5): This is a base flow recommended to sustain <u>good</u> survival habitat for most aquatic life forms. Widths, depths, and velocities will generally be satisfactory (Fig. 1). The majority of the substrate will be covered with water, except for very wide, shallow riffle or shoal areas. Most side channels will carry some water. Most gravel bars will be partially covered with water and many islands will provide wildlife nesting, denning, nursery, and refuge habitat in many reaches. Many runs and most pools will be deep enough to serve as cover for fishes. Riparian vegetation should not suffer from lack of water. Large fish should have no trouble moving over most riffle areas. Water temperatures are not expected to become limiting in most stream segments. Invertebrate life is reduced but not expected to become a limiting factor in fish production. Water quality and quantity should be good for fishing, floating, and general recreation, especially with canoes, rubber rafts, and smaller shallow draft boats (streams with an average flow of more than 100 cfs). Stream esthetics and natural beauty will generally be satisfactory."

"Ten percent (10%) of the average flow (Fig. 4): This is a <u>minimum</u> instantaneous flow recommended to sustain short-term survival habitat for most aquatic life forms. Channel widths, depths, and velocities will all be significantly reduced and the aquatic habitat degraded (Fig. 1). The stream substrate or wetted perimeter may be about ½ exposed, except in wide, shallow riffle or shoal areas where exposure could be higher. Most side channels will be severely or totally dewatered. Most gravel bars will be substantially dewatered, and islands will usually no longer function as wildlife nesting, denning, nursery, and refuge habitat. Streambank cover for fish and fur animal denning habitat will be severely diminished. Many wetted areas will be so shallow that no longer will serve as cover, and fish will generally be crowded into the deepest pools. Riparian vegetation may suffer from lack of water. Large fish may have difficulty migrating upstream over many riffle areas. Water temperature may become a limiting factor, especially in the lower reaches of the stream in July and August. Invertebrate life will be severely reduced. Fishing will often be very good in the deeper pools and runs since fish will be concentrated. Many fishermen prefer this level of flow! However, fish may be vulnerable to overharvest. Floating is usually difficult even in a canoe or rubber raft (streams with an average flow of more than 100 cfs). Natural beauty and stream esthetics are badly degraded. Most streams carry less than 10% of the average flow at times, so even this low level of flow will occasionally provide some enhancement over a natural flow regimen."

RESULTS

Let me say here that data for this analysis is computerized and the results are rather voluminous. While I will only summarize the results here, a complete presentation and analysis will eventually by published under the WRC label as an appendix to the Nationwide Analysis.

Preliminary evaluations of the annual depletion levels at the outflow point(s) of the ASAs for the mean water conditions illustrate the geographic distribution of the gross water adequacy situation. We see in Figure 6 that the current situation is extremely severe in the southwest, the Platte River and headwaters of the Arkansas. And, further, that depletions exceed 40 percent in the high plains and portions of the Pacific Northwest and California. Indications of potential problem areas are indicated by the stippled areas where depletions are approaching the 40 percent level.

Figures 7 and 8 show the comparable situation for 1985 and 2000, respectively, assuming the projected future as currently contemplated by the Federal agencies (known as the Modified Central Case). This future is basically based on OBERS E population projections and assumes full implementation of P.L. 92-500. It does not reflect full scale development of potential coal and oil shale resources currently being investigated by others. The driving force producing these changes is a significant increase in irrigation to meet assumed high export levels of certain agricultural products.

Figure 9 presents a more illustrative picture indicating the net change in the annual depletion ratios between 1975 and 2000. The reduced depletion levels for the most part, reflect assumed reduced groundwater supplies due to depleted acquifers resulting in less irrigation than presently occurs. In California the responsible factors include high water costs, land constraints, water efficiencies and the acreage in citrus crops.

In the dry years the relative pattern is very similar but the depletion ratios are, of course, higher.

We all know that annual depletions tend to understate the real problem. To compare the data for each month would require more time than is available here. However, it is informative, from the viewpoint of instream values, to look at the areas where the mean monthly depletions exceed the 40, 70 and 90 percent criteria one or more months.

Figure 10 sets the stage with the 1975 conditions. We see here a current encroachment upon optimum instream conditions (40 percent depletion) throughout most of the west. The cross-hatched area indicates depletion greater than 70 percent or less than the desired minimum. And for much of the arid west, we have already depleted the water supply more than 90 percent which is equated to loss of aquatic life and the attendant instream values. In southern Florida the large diversions have substantially reduced the famous "river of grass" known as the Everglades.

Figures 11 and 12 present comparable information for 1985 and 2000, respectively, to that of Figure 10 for 1975. They indicate that, given the MCC projected use, the instream conditions would worsen significantly in the Missouri, Pacific Northwest, Colorado, and Arkansas-Red-White regions.

We must remember that the data reflect conditions at the outflow point of an ASA based on all upstream use and manipulations of supply. It is, therefore, possible for tributary streams to support viable fisheries while the mainstream condition is severely depleted or conversely, for severe instream flow problems to exist in some tributaries which are not reflected in the depletion ratios.

When the Present Modified Flows (1975) and Future Modified Flows (1985 and 2000) are compared with the independently developed Instream Flow Approximations, the areas of conflict present an interesting picture. In 1975, only a handful of problem areas are indicated (Figure 13). The assumed projections for 1985 and 2000 will result in Future Modified Flows which conflict with IFAs in most ASAs (Figure 14).

Probably the most significant factor in this exercise is the relative validity of the IFAs themselves. As indicated earlier these numbers are in some cases based on rather crude assumptions and most be refined during future Level B and C studies before implementation decisions are made.

Another map sheds additional light on the "Big Picture" relative to instream flows. Figure 15 illustrates the collective views of 21 regional sponsors who identified instream flows as an aspect of a problem area. Differences between it and previous maps can be attributed to differing biases and perspectives with regard to what is a problem, degree of geographic definity, and perhaps differing definitions of terms. At any rate, it is obvious that instream flows are considered a major problem in many parts of the Nation by more than a few people.

This really is not surprising to those of us who have been involved with this subject for any length of time. But it is encouraging that the 1975 National Water Assessment will give instream flow problems high visibility and that this should in turn facilitate attempts to obtain funding and positions for the massive effort that is indicated.

SUMMARY AND CONCLUSIONS

This analysis was not intended to reveal all areas where instream flows are a problem. It does give a good indication of the relative flexibility we have in coping with increased pressure on our fluvial ecosystem.

While it stresses the severity of the western water problems, it also indicates that instream flows are of concern in the east as well.

The National Water Assessment illustrates what many of us already know--that decisions regarding future water use in the agricultural sector dominate the future of instream values. Also, the next ten years are expected to be critical as planners seek acceptable solutions to the water problems of the west.

The public has given us clear signals that they desire preservation of the instream flow values. Ongoing and future planning and decision making must not merely consider instream values but actively provide protection from withdrawal for a sufficient amount of water to provide for these values. This places the pressure squarely on us to develop improved data collection and analytical techniques for systematic determination of instream flow requirements and to work out solutions to the institutional problems which have thus far hampered efforts to implement recommendations.

To attain this goal, priority attention for instream flow studies is required. However, it is obvious that we cannot afford the luxury of a long, drawn out program of consecutive studies. Rather, we need a blanket attack to close the data gap for approximately 50% of the Nation in the next few years.

Such an effort must involve many individuals, disciplines, and agencies. Success in this approach requires a center where communication can be facilitated, information stored for rapid retrieval and methodology research coordinated.

The Cooperative Instream Flow Service Center was conceived to provide these services. Bob Hayden is reporting on this new program at this conference. I encourage each of you to examine your respective programs and determine how you can best assist in making it a truly multi-disciplinary, multi-agency effort.

Major decisions regarding this Nation's investment in water resource development should be based on objective analysis of the relative water requirements and available supplies. The Water Resources Council's 1975 National Water Assessment indicates the instream component of the water requirements need better definition and more prominence in the allocation of our resources.

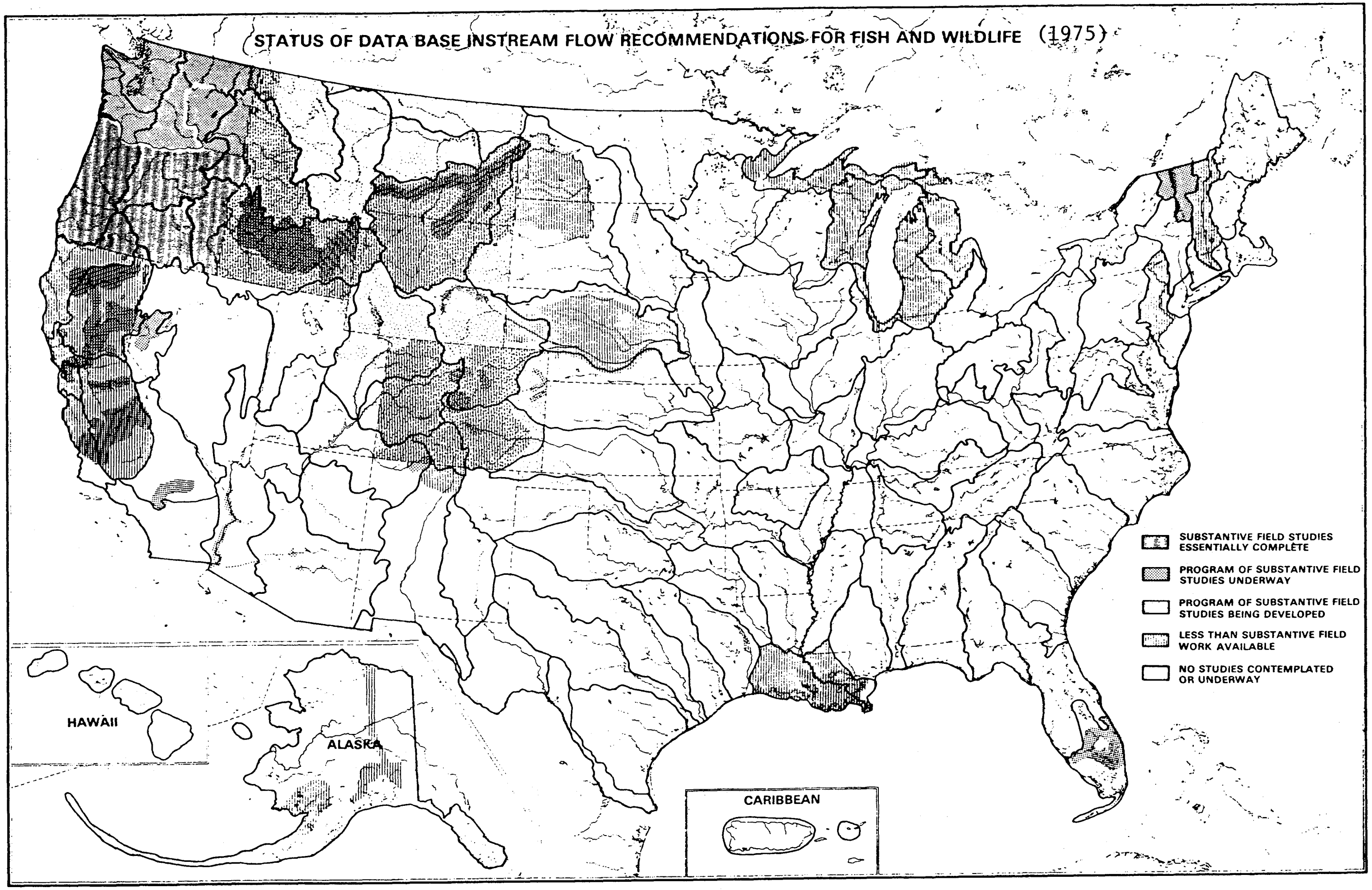


FIGURE 1. 1975 STATUS OF DATA BASE FOR INSTREAM FLOW RECOMMENDATIONS FOR FISH AND WILDLIFE

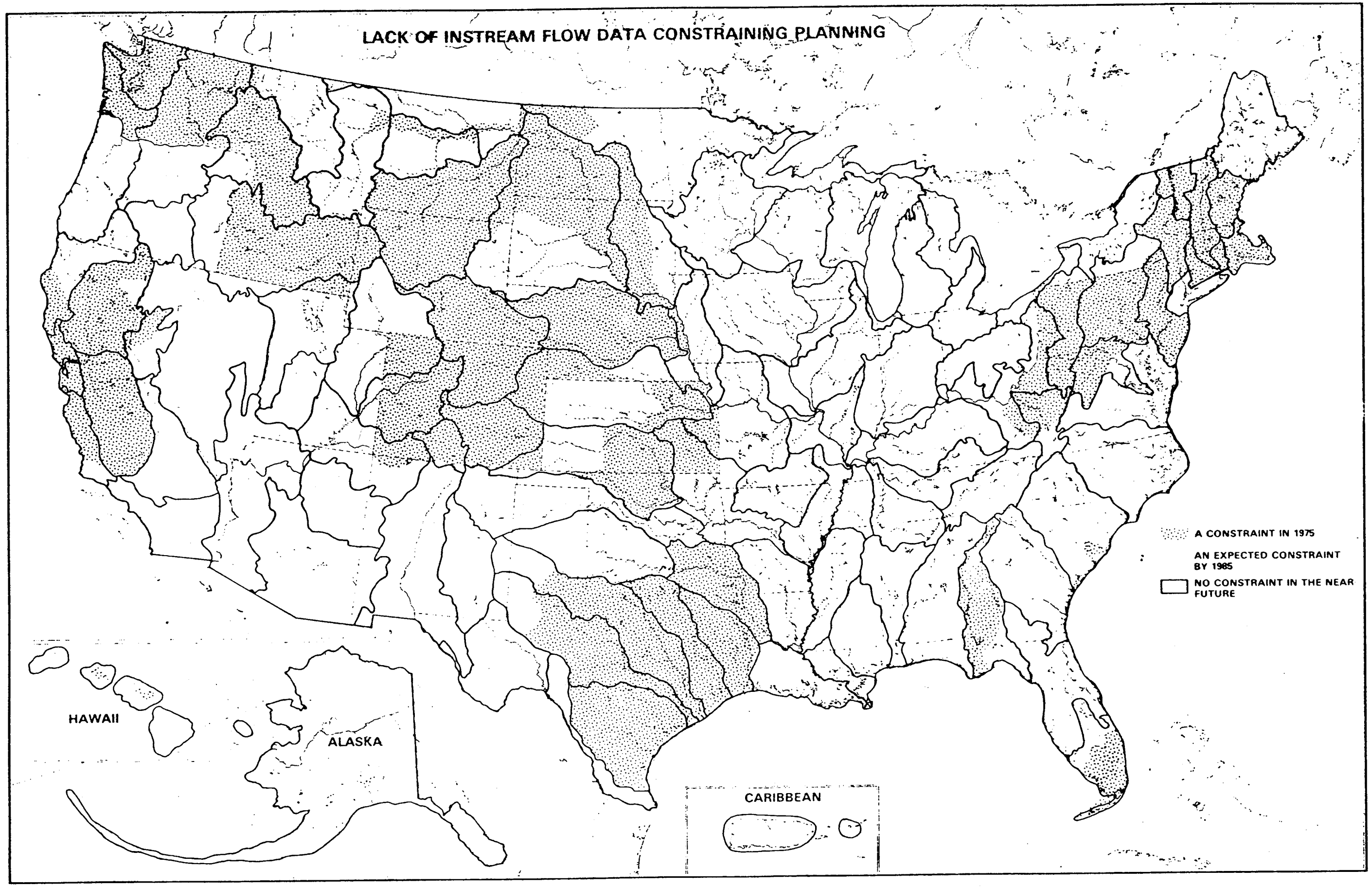
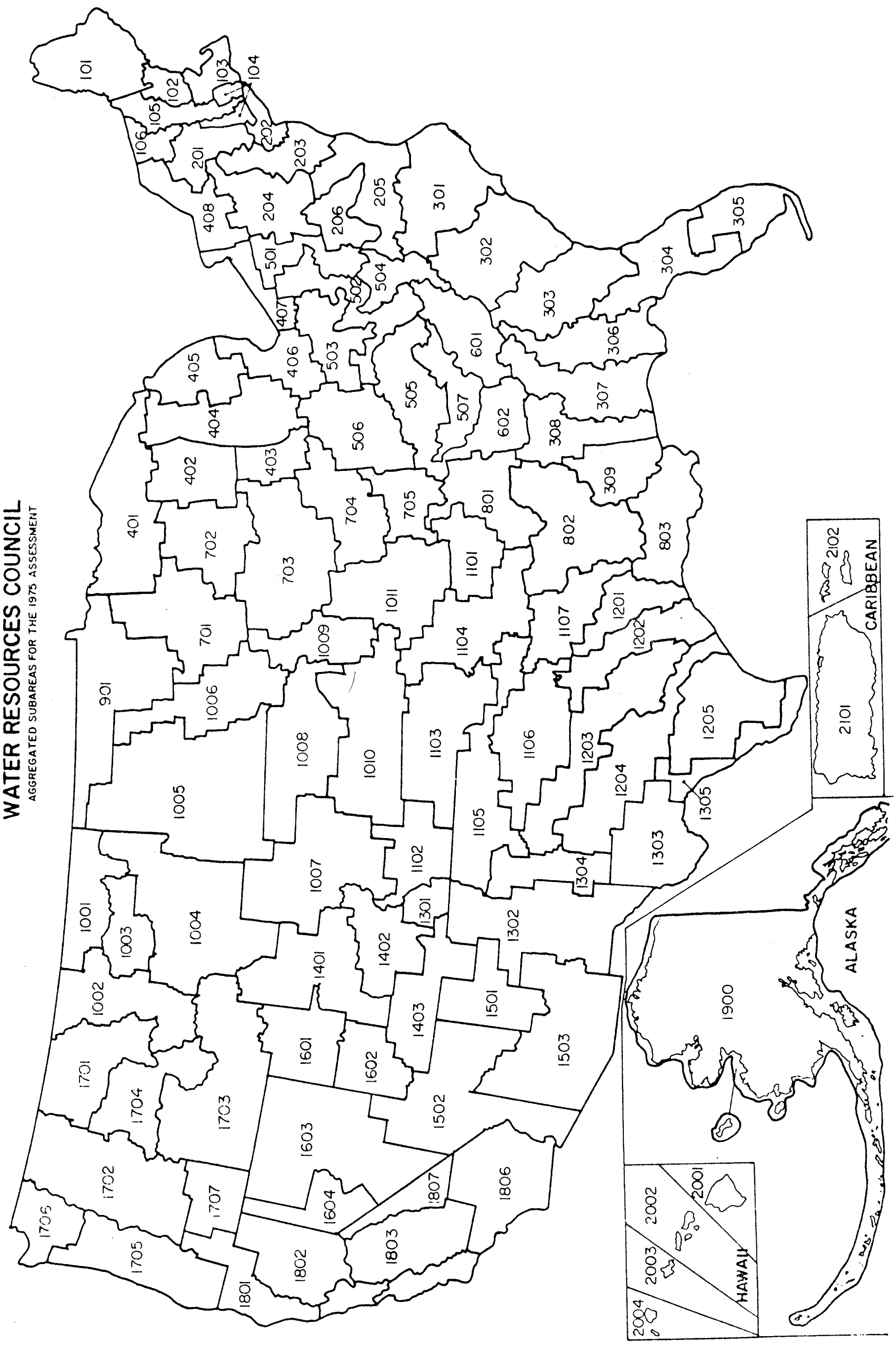


FIGURE 2. AREAS IN WHICH LACK OF INSTREAM FLOW DATA IS CONSTRAINING EFFECTIVE WATER RESOURCE PLANNING IN OPINION OF FWS FIELD PERSONNEL

FIGURE 3

WATER RESOURCES COUNCIL

AGGREGATED SUBAREAS FOR THE 1975 ASSESSMENT



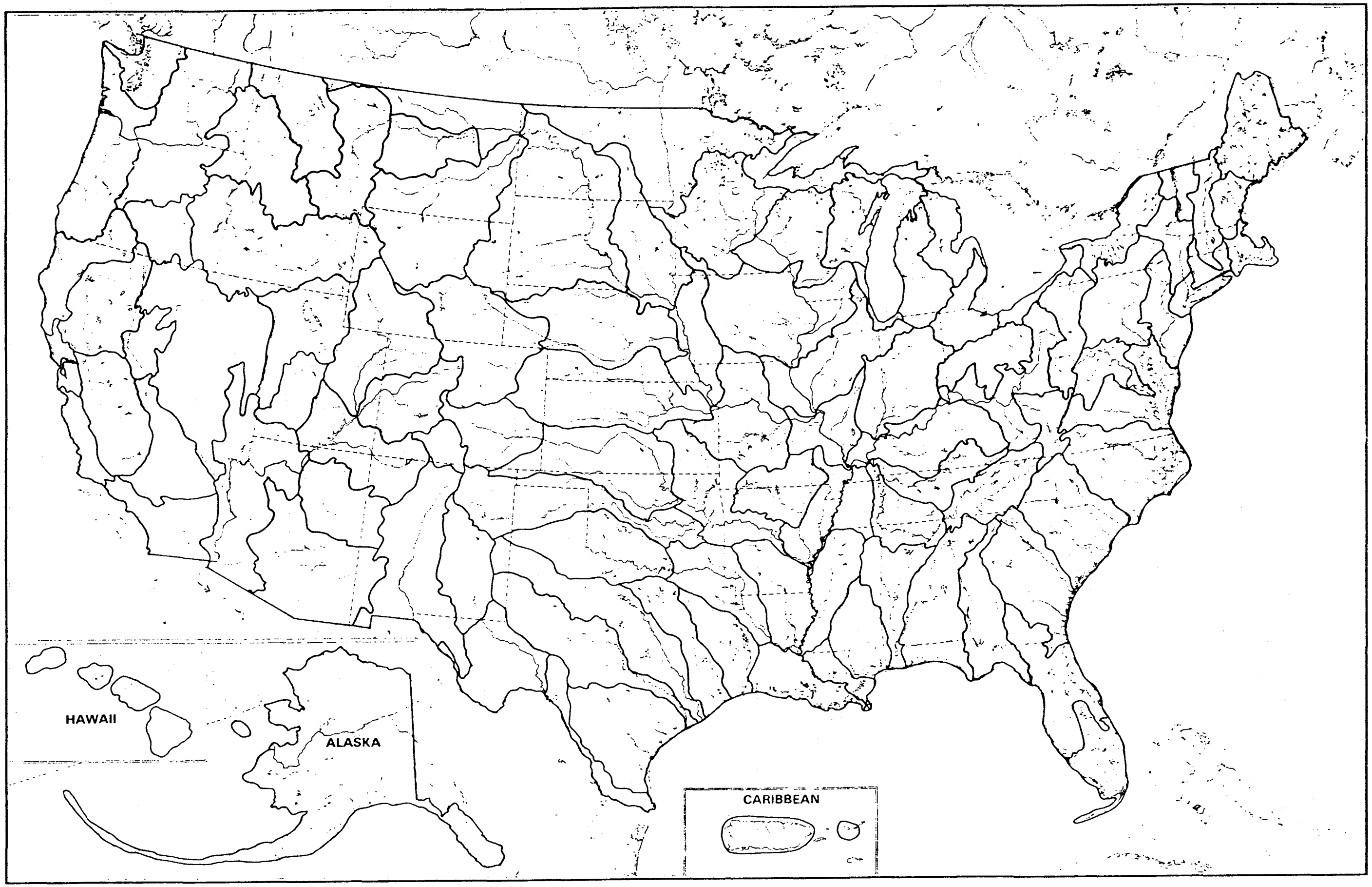


FIGURE 3a HYDROLOGIC EQUIVALENTS OF AGGREGATED SUBAREAS

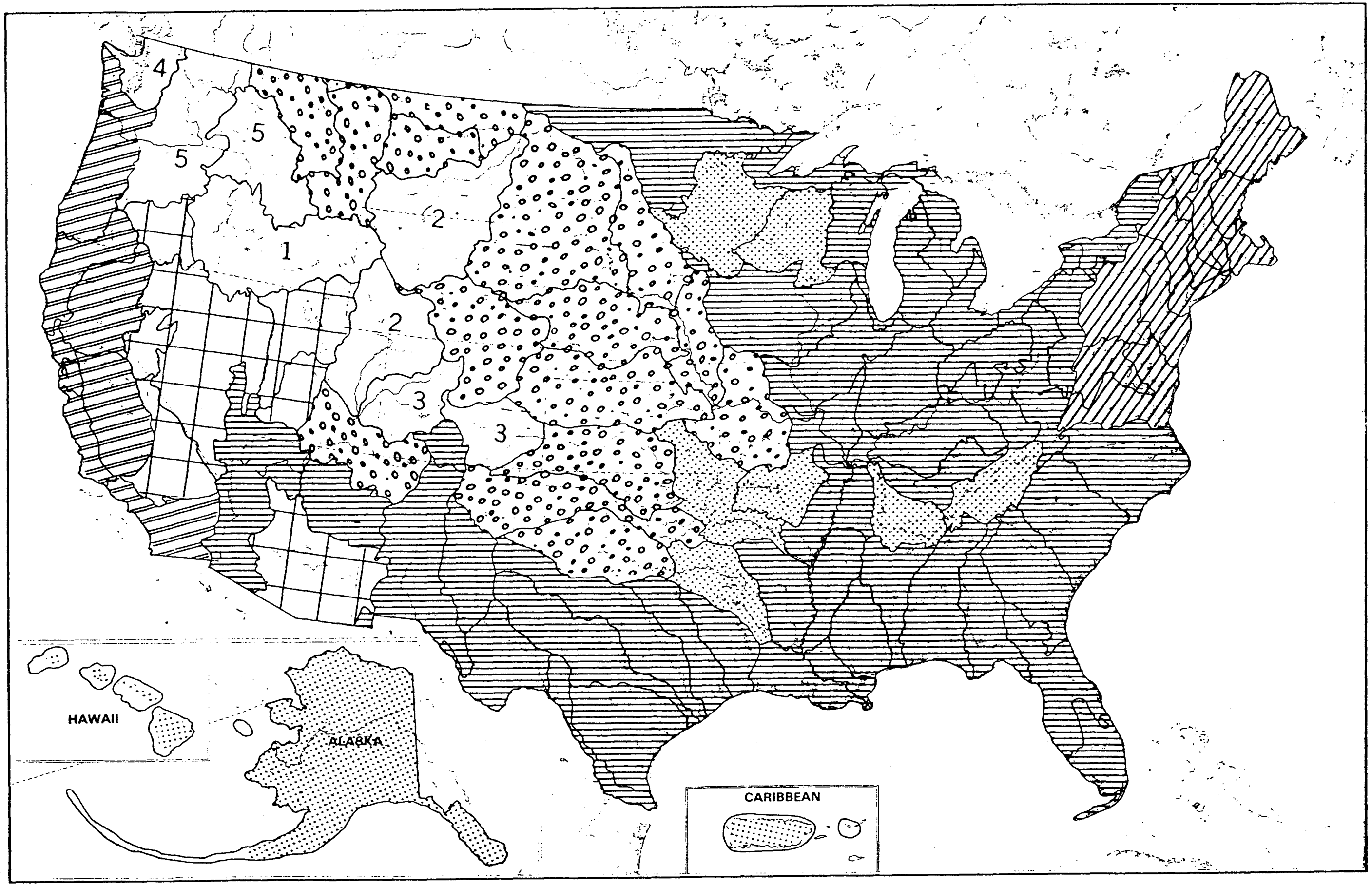


FIGURE 4. GEOGRAPHIC APPLICATION OF VARIOUS METHODOLOGIES USED IN DEVELOPMENT OF INSTREAM FLOW APPROXIMATIONS, AUGUST, 1975

LEGEND FOR FIGURE 4.

Based on specific studies:

1. Anatomy of a River
2. Northern Great Plains Resource Program, studies by Jones, et. al.
3. Hoppe & Finnell - Aquatic Studies on Fryingpan River
4. Puget Sound and Adjacent Waters Study
5. Columbia Basin Fishing Technical Committee's provisional recommendations

Mean flows as reported in USGS Water Supply Statistics for the 1975 National Water Assessment

Median flows as reported in USGS Water Supply Statistics for the 1975 National Water Assessment

Montana Method or Montana Method modified

Montana Method in combination with Connecticut River Criteria

Judgmental estimates based on USGS discharge data into terminal lakes or ground water aquifer

In consultation with State biologists with access to specific site studies

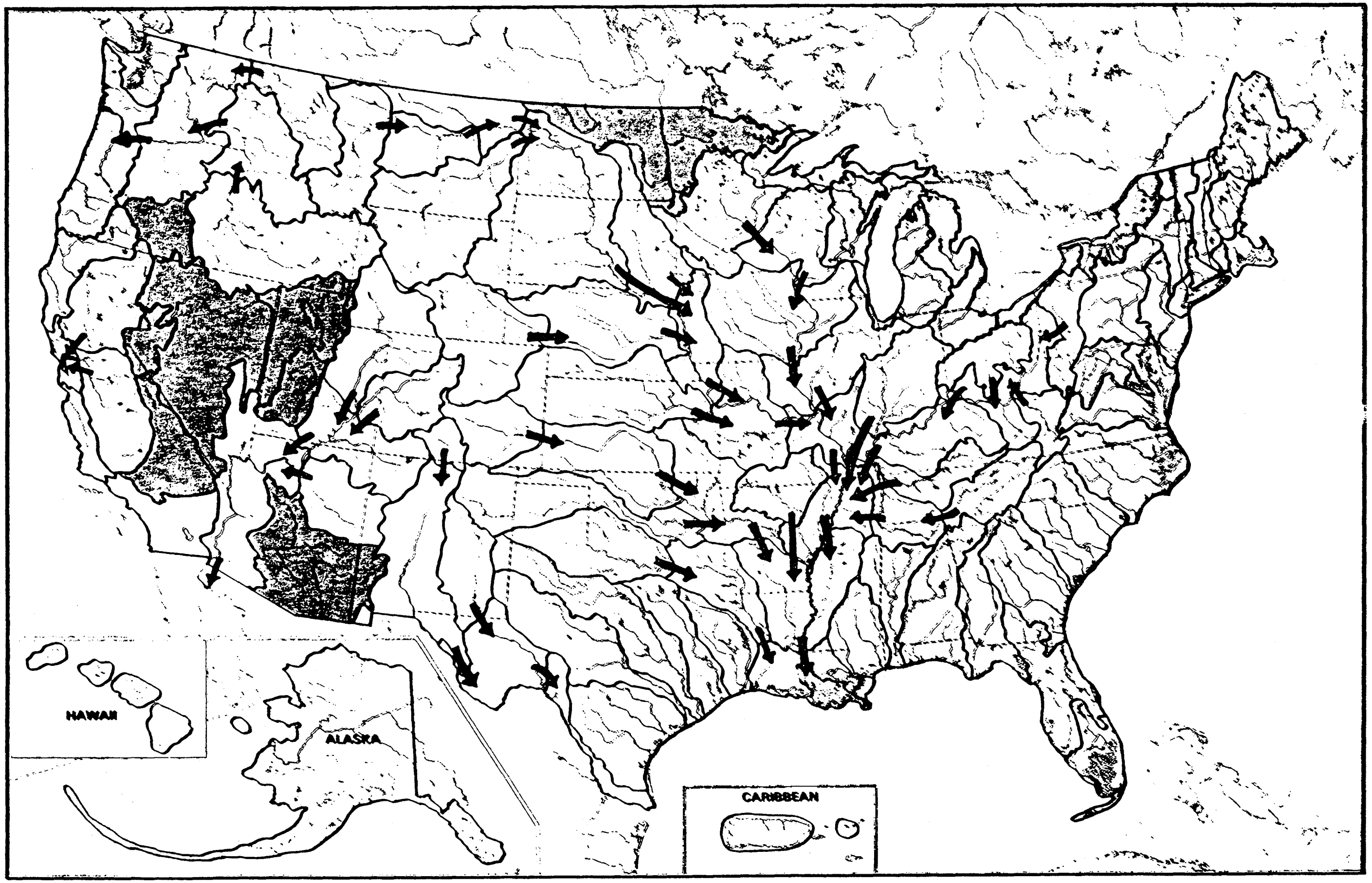


FIGURE 5. INTER-ASA FLOW PATTERN ASSUMED IN COMPUTER PROGRAMMING FOR VOLUMETRIC ANALYSIS

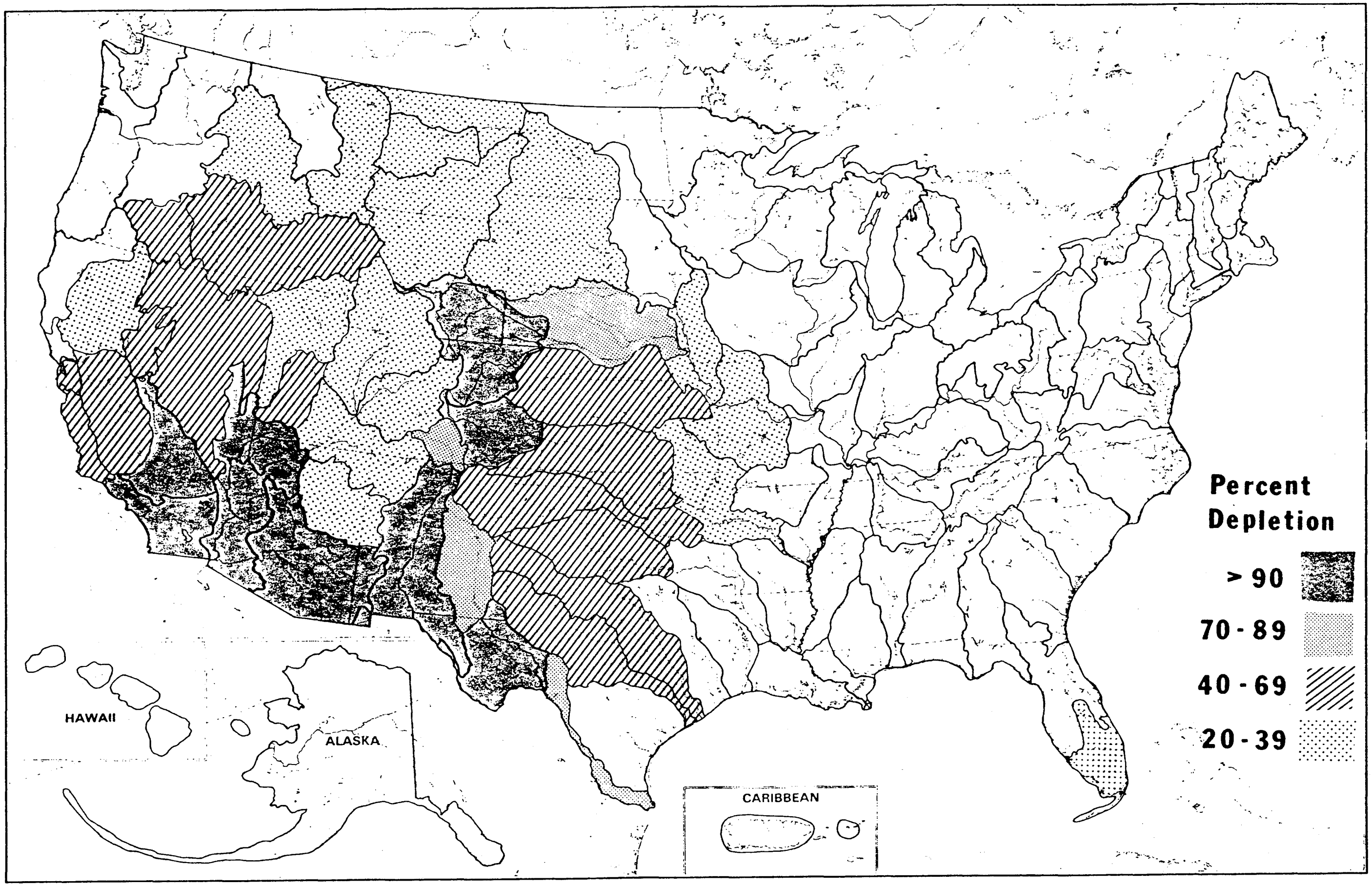


FIGURE 6. ANNUAL DEPLETIONS WITH MEAN WATER SUPPLY CONDITIONS AND 1975 WATER REQUIREMENTS

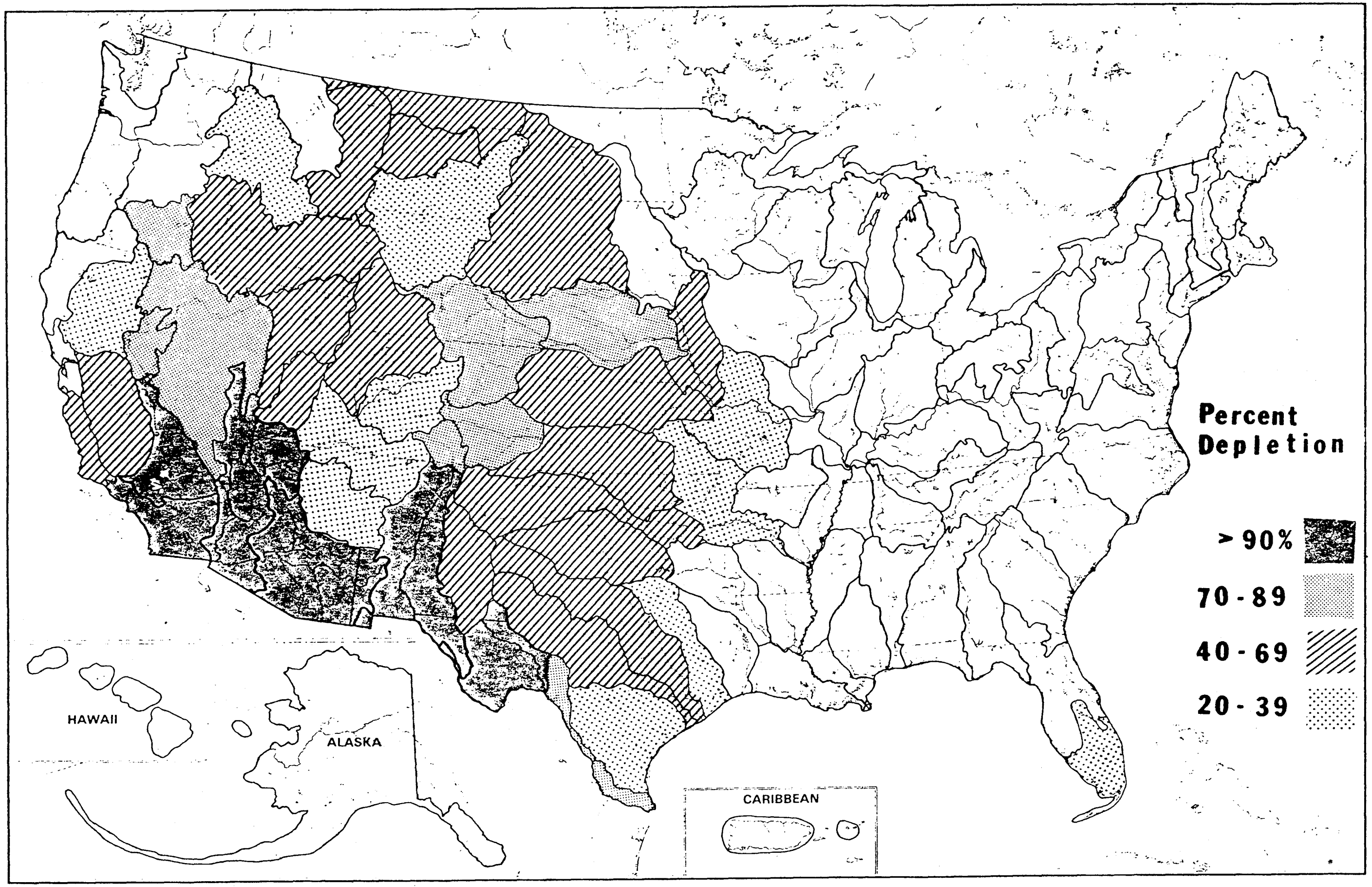


FIGURE 7. ANNUAL DEPLETIONS WITH MEAN WATER SUPPLY CONDITIONS AND 1985 WATER REQUIREMENTS

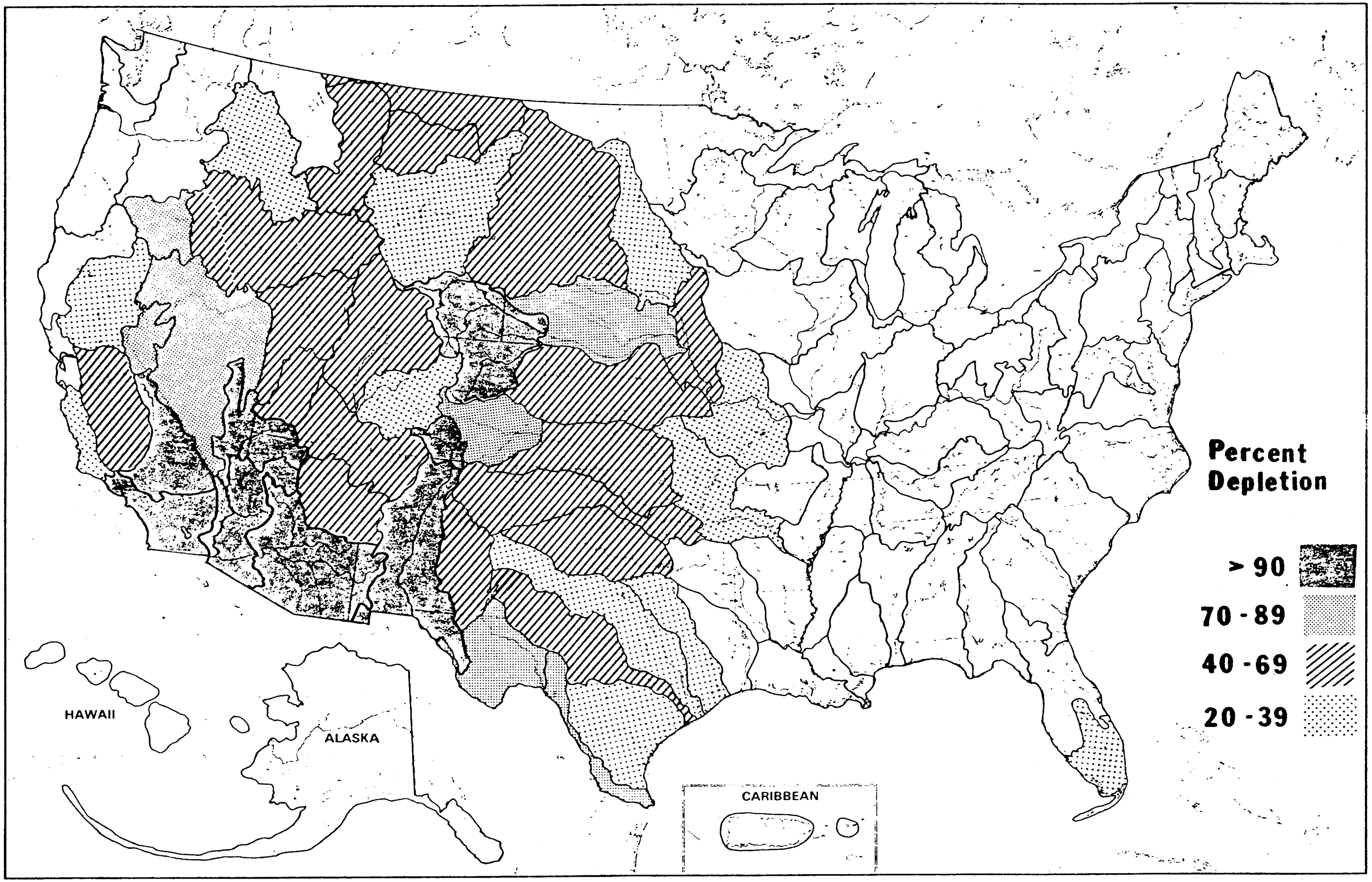


FIGURE 8. ANNUAL DEPLETIONS WITH MEAN WATER SUPPLY CONDITIONS AND 2000 WATER REQUIREMENTS

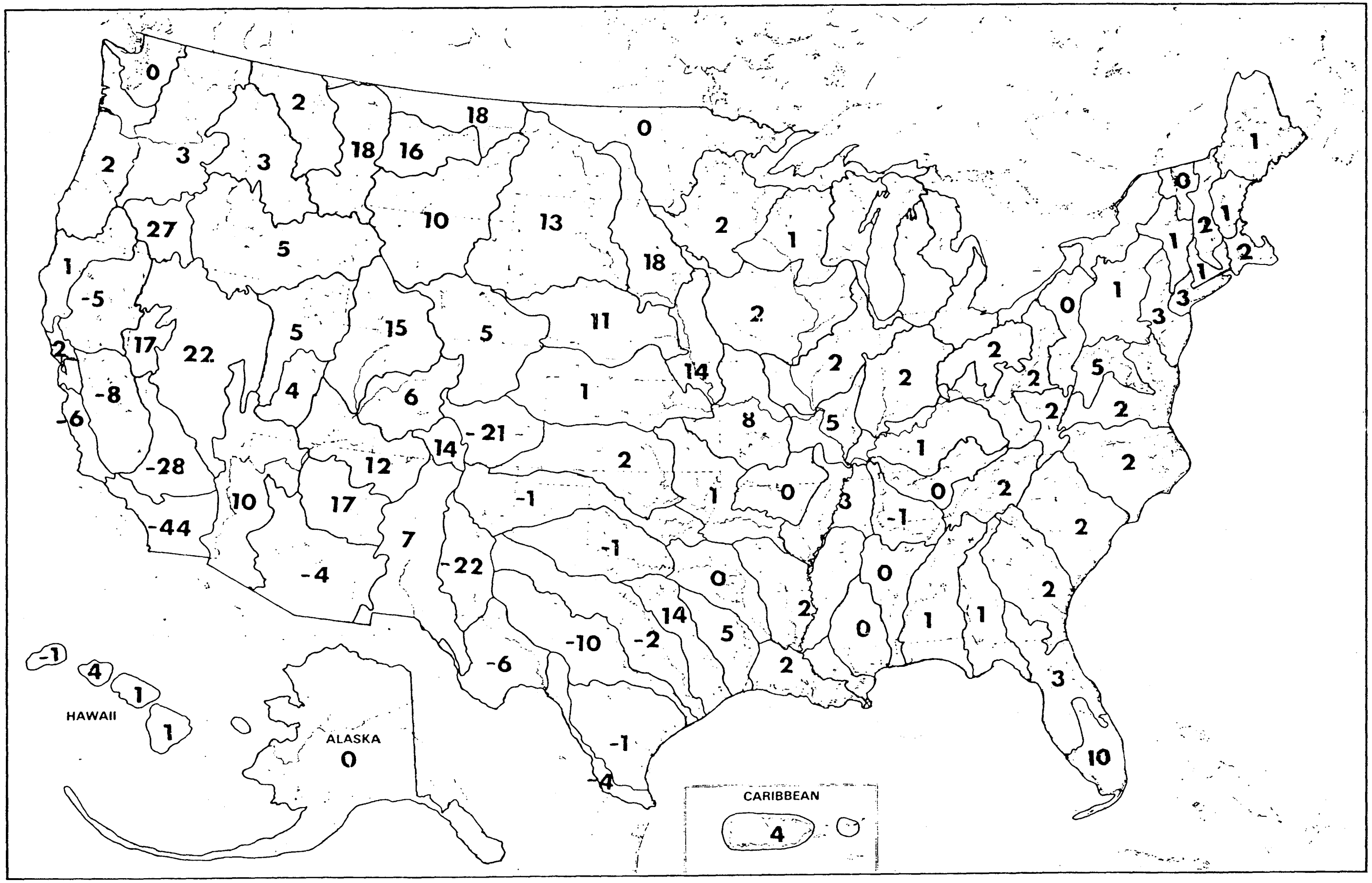


FIGURE 9. NET CHANGE IN PERCENT DEPLETION OF MEAN OUTFLOW FROM 1975 TO 2000

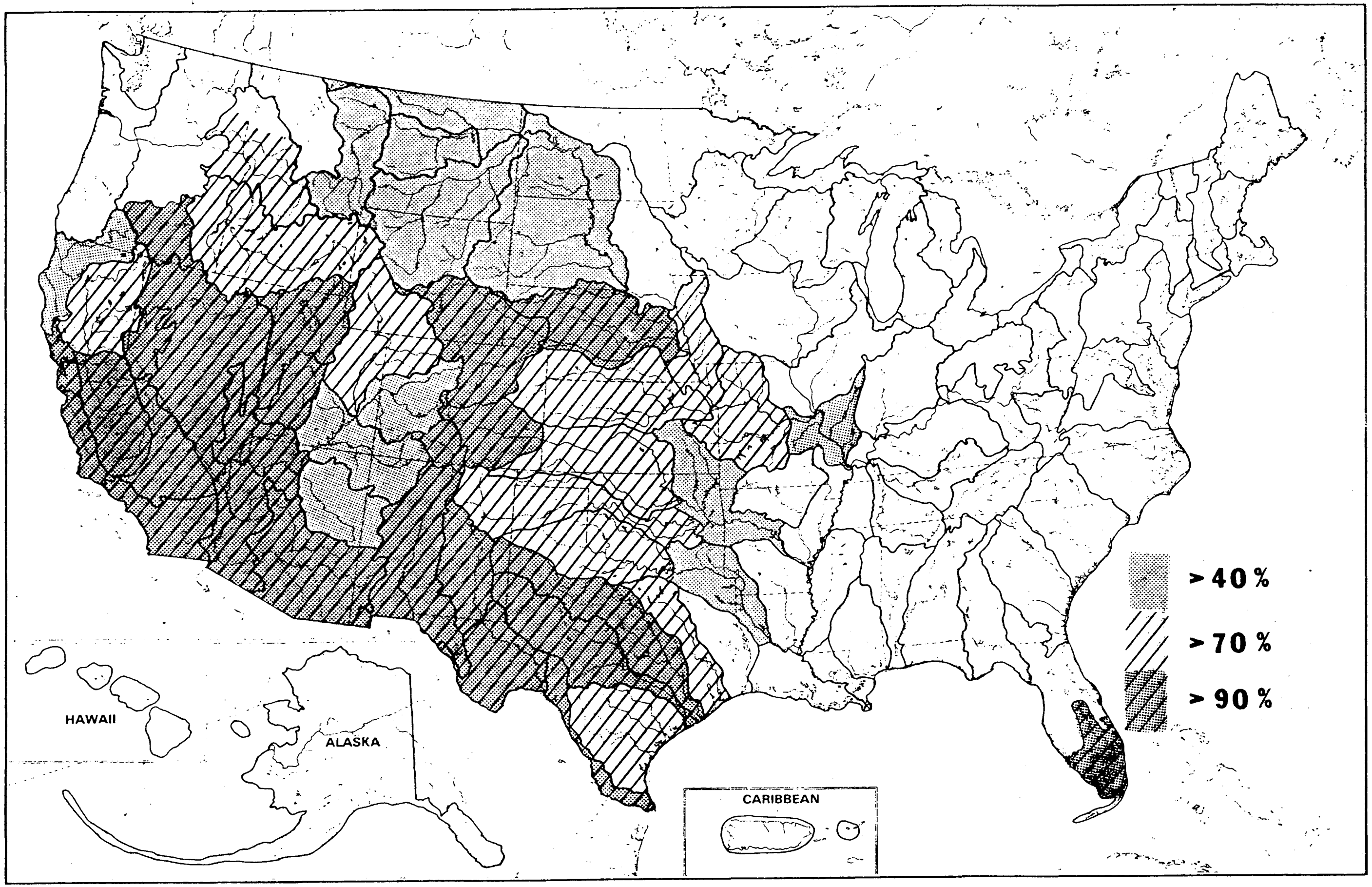


FIGURE 10. AREAS WITH ONE OR MORE MONTHS IN WHICH THE MONTHLY DEPLETION RATIO GREATER THAN 40, 70 AND 90%, USING DRY YEAR (95% EXCEEDENCE) WATER SUPPLY CONDITIONS AND 1975 WATER REQUIREMENTS

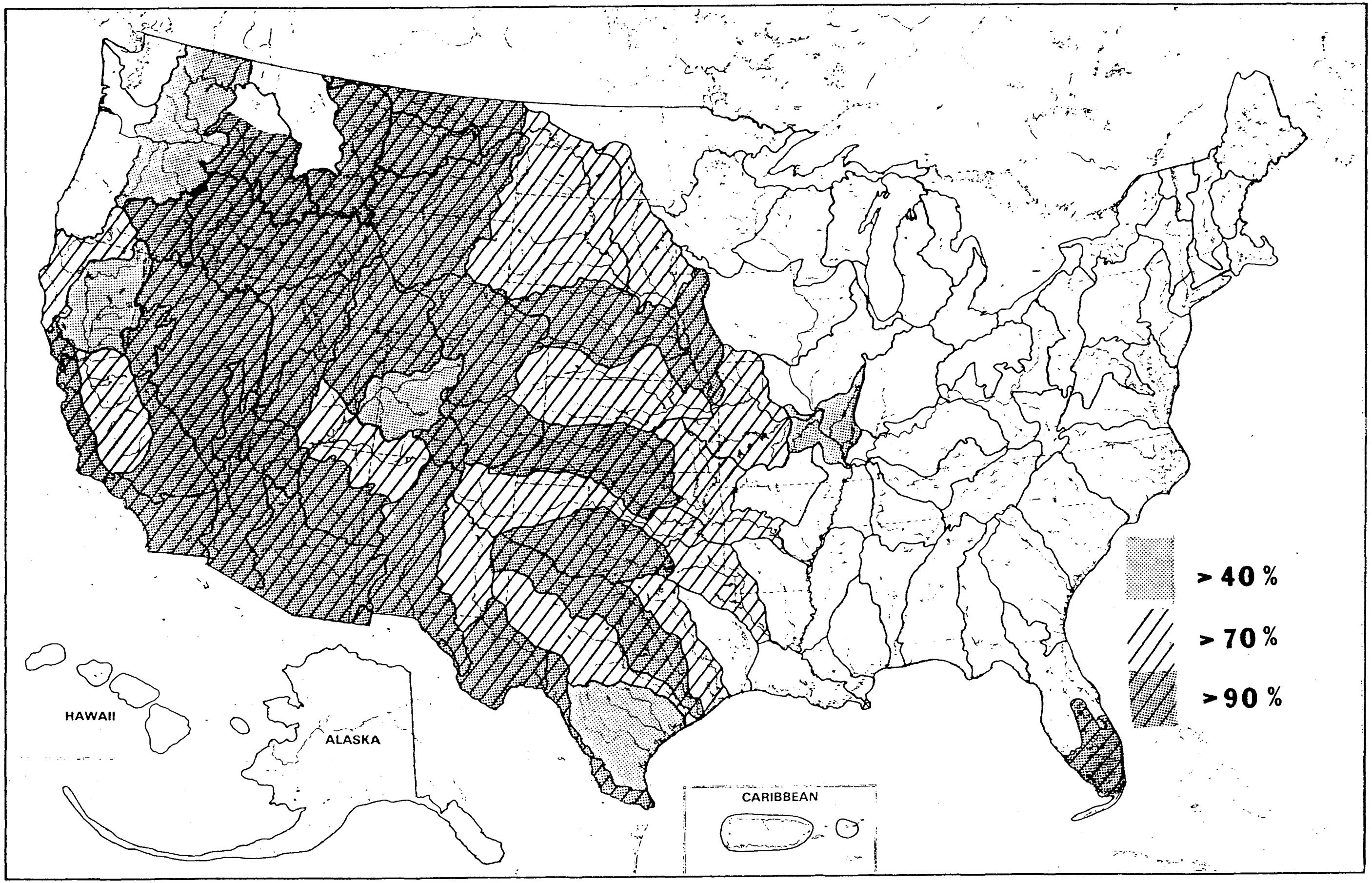


FIGURE 11. AREAS WITH ONE OR MORE MONTHS IN WHICH THE MONTHLY DEPLETION RATIO WOULD BE GREATER THAN 40, 70 and 90%, USING DRY YEAR WATER SUPPLY CONDITIONS AND 1985 WATER REQUIREMENTS

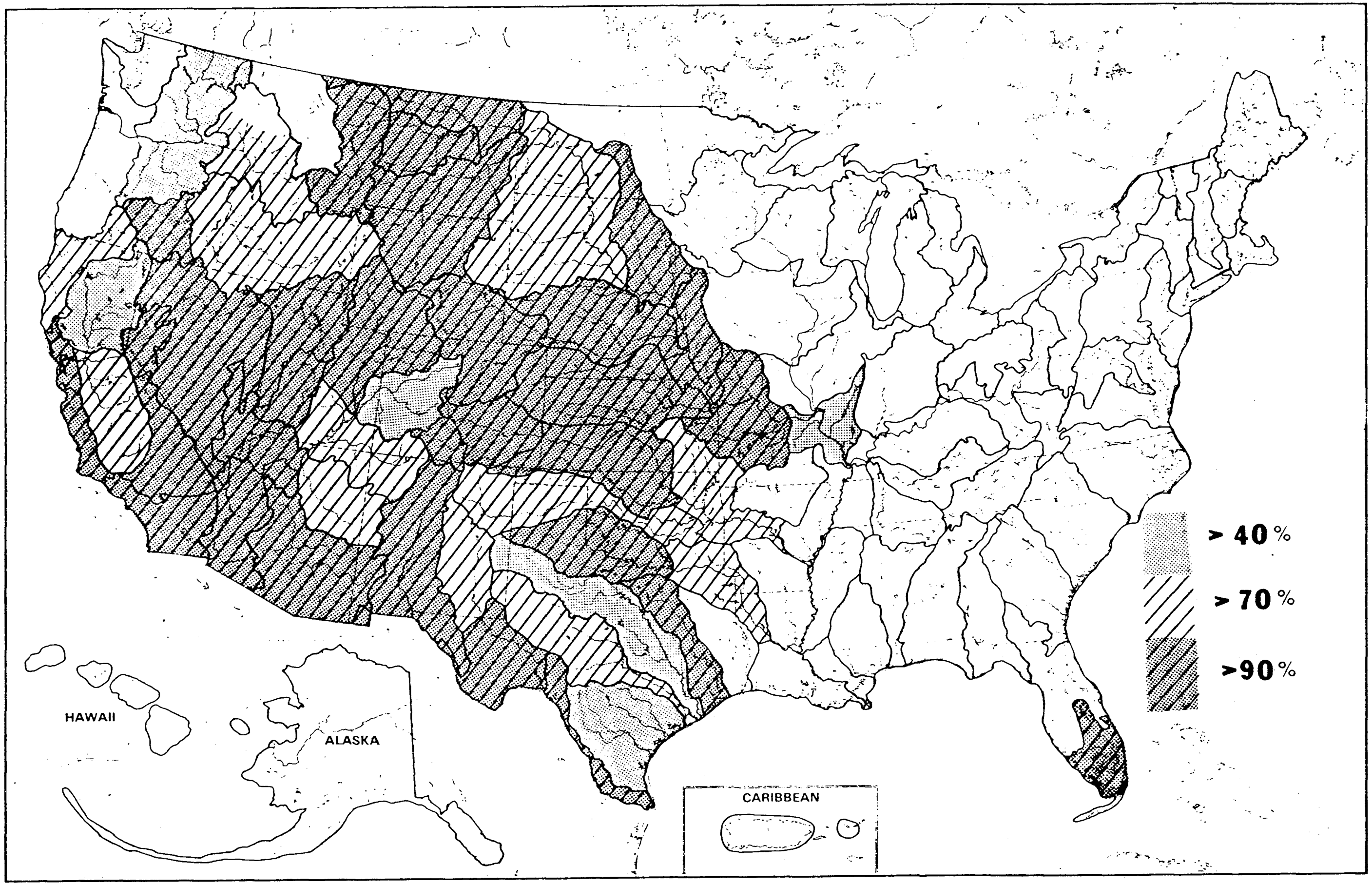


FIGURE 12. AREAS WITH ONE OR MORE MONTHS IN WHICH THE MONTHLY DEPLETION RATIO WOULD BE GREATER THAN 40, 70 and 90%, USING DRY YEAR WATER SUPPLY CONDITIONS AND 2000 WATER REQUIREMENTS

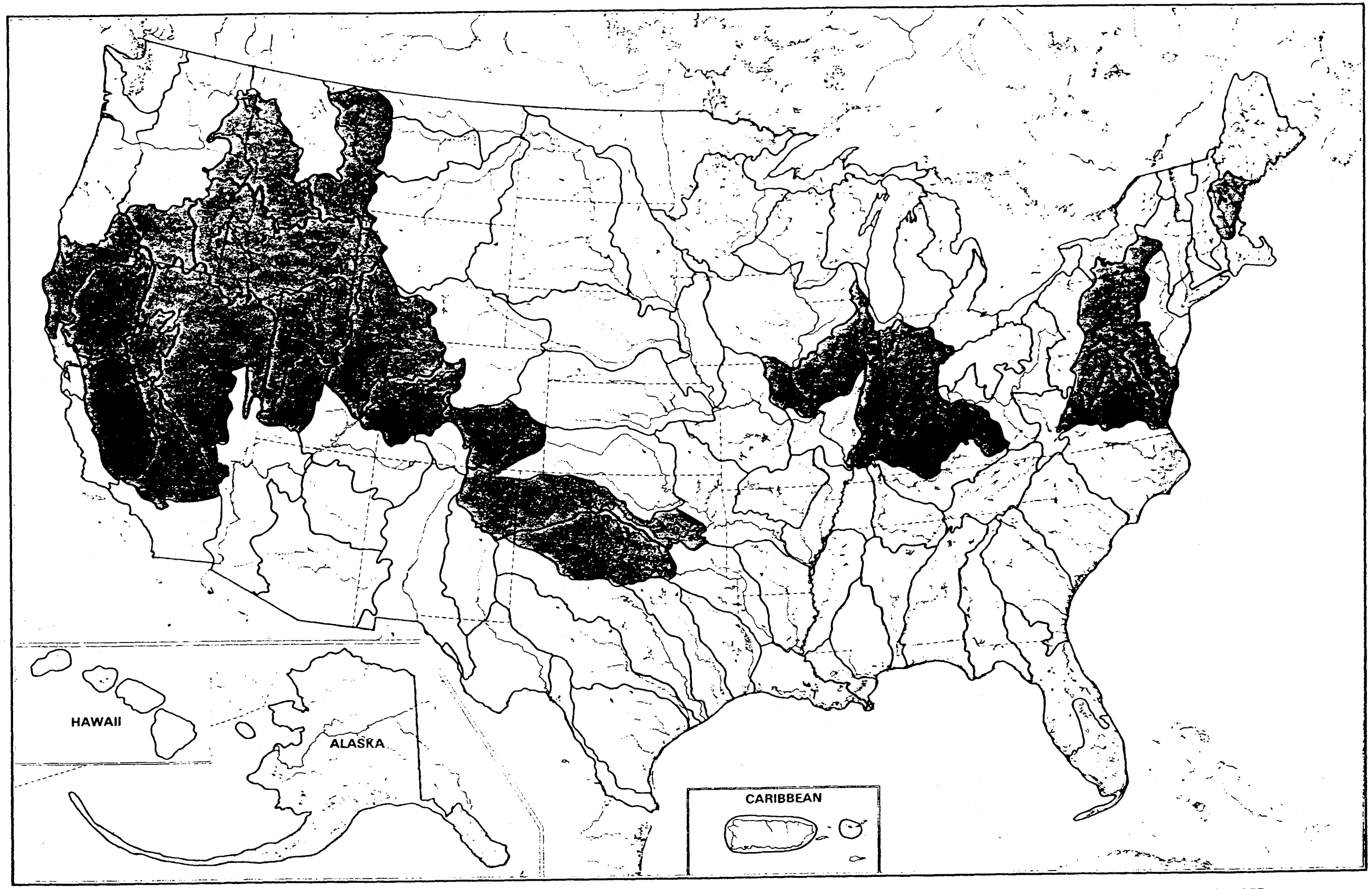


FIGURE 13. ASAs WITH CONFLICTS BETWEEN INSTREAM FLOW APPROXIMATIONS AND PRESENT MODIFIED FLOW

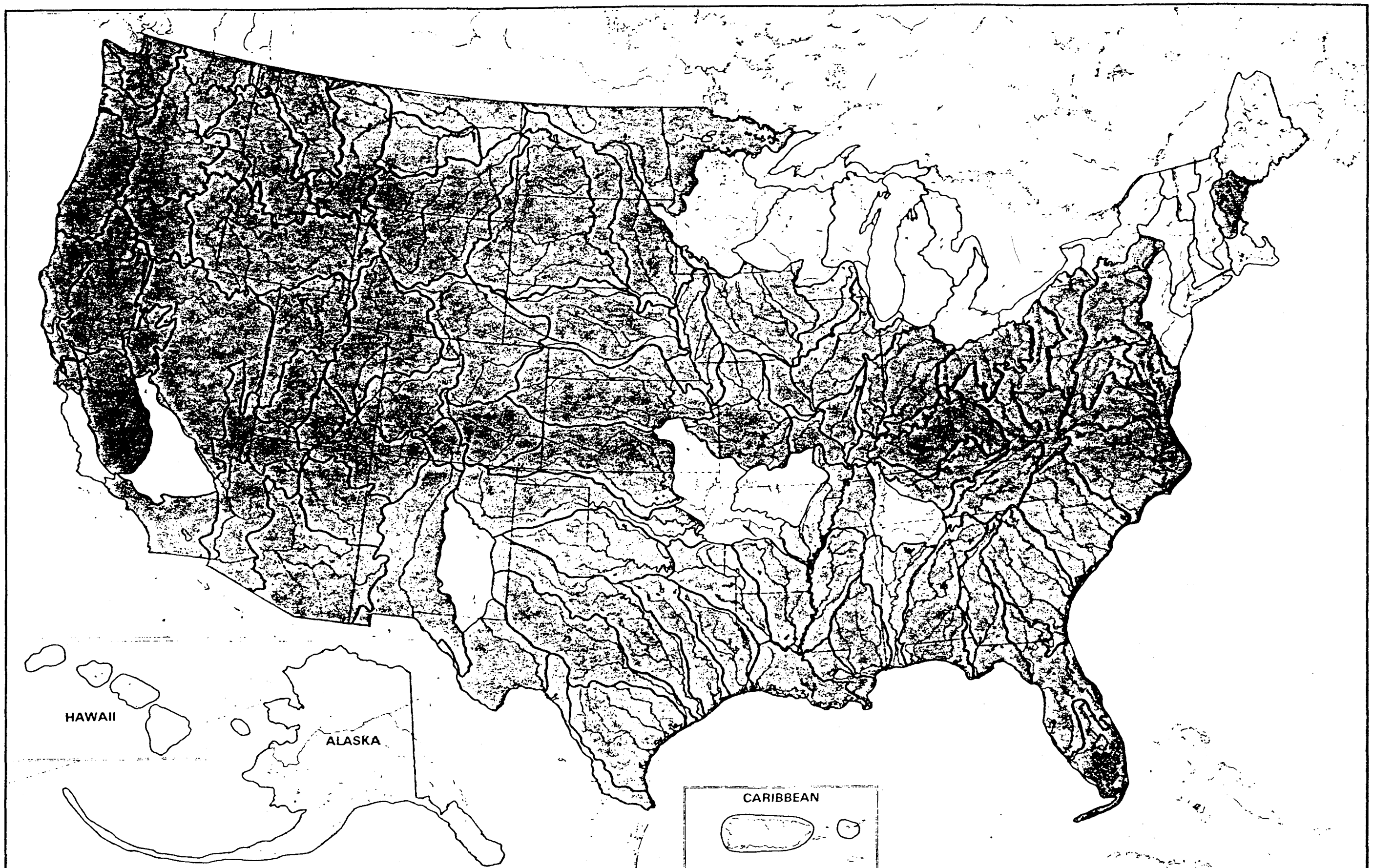


FIGURE 14. ASAs WITH CONFLICTS BETWEEN INSTREAM FLOW APPROXIMATIONS AND FUTURE MODIFIED FLOW

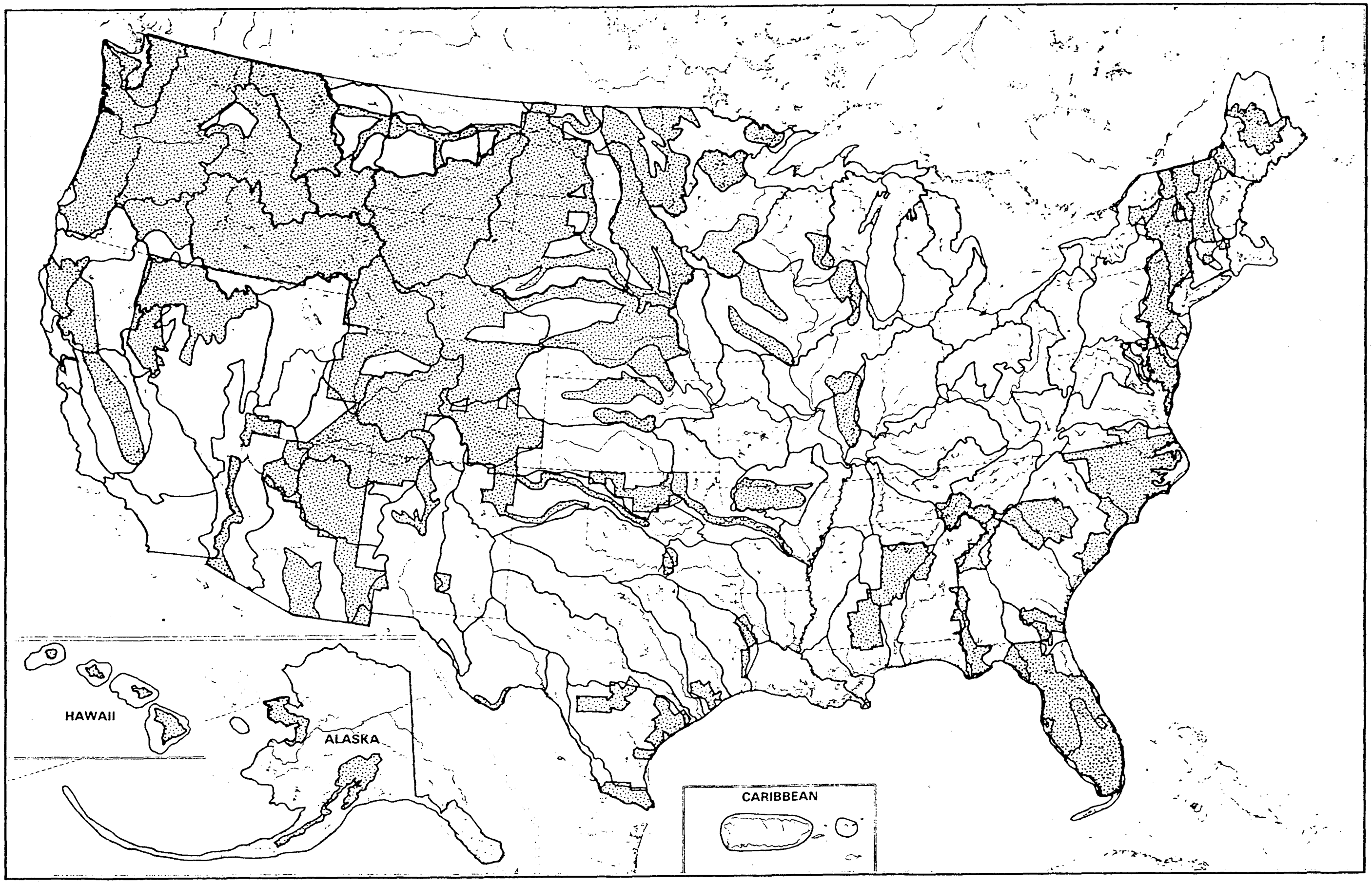


FIGURE 15. PROBLEM AREAS IDENTIFIED BY REGIONAL SPONSORS AS HAVING IFN AS AN ASPECT OF THE PROBLEM

APPENDIX A

Updated
April 29, 1976

---- Modified Central Case ----
Water Requirements; Water Supplies
and Comparison Thereof

This document describes the types of water requirements and supply information contained in the Assessment's Modified Central Case for each Aggregated Subarea (ASA). It also describes the types of comparisons displayed as a result of comparing supplies and requirements for each ASA. For descriptive purposes, the displays are categorized into five types of displays as shown in the Annotated Table of Contents accompanying the February 20, 1976 Volumetric Analysis, and attached hereto for reference.

Water Requirements*

Eleven functional use categories are displayed on display 1. In addition man-made evaporation and net exports are displayed. The sum of all of these types of water use is called "net depletions." Finally, the amount of water withdrawn from groundwater in support of meeting the "net depletions" is displayed. Display 2 summarizes consumptive use by functional use.

All numbers are expressed in millions of gallons per day. Both annual and selected monthly values are shown for usage within the ASA shown at the top of the sheet. Only fresh water use is shown.

Detailed methodology and assumptions work statements are available in a separate document; however, several important points affecting how the numbers should be used are discussed below.

1. Domestic Central--Per capita use for population served was assumed not to change from 1975 conditions. Also, our source of information did not necessarily include all commercial use (e.g., hotels, casinos, fire fighting, etc.). Therefore, in ASAs where this functional use is significant (e.g., 15 to 20% of the total use), careful attention should be given to reviewing the uncertainty in the data base and basic assumptions and the number adjusted accordingly. The data base is USGS Circular 676.

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*Contained in Displays 1 and 2.

2. Manufacturing -- Some industries do not operate 365 days per year; therefore, two different values for mgd were provided by Commerce. The first was an annual value which reflected the average mgd value for the days of actual operation. The second value was a value which reflected the total gallons per year divided by 365 days per year. The display contains numbers in mgd corresponding to the second value. To convert from the first to the second value the following coefficients should be used:

0.6849	Food and Kindred Textile Mills Transportation Machinery All Other Manufacturing
0.9041	Paper, Pulp, and Board Chemicals
0.9589	Petroleum Refining
1.0	Primary Metals

3. Crop Irrigation -- Three different values for crop irrigation were provided by USDA, and all are used at various places in the display. The first value represents an average year requirement value --- that amount of water required to support excellent crop production without crop stress in an average year. The second value represents a dry year requirement -- that water required to support crop production without crop stress in an 80% frequency dry year (i.e., that amount of water required in 2 out of every 10 years). The third value represents actual estimated use -- that amount of water actually used in an average (mean) year considering that in actual conditions (1) crop stress does actually occur, (2) distribution system losses may be different than assumed in the calculation of requirements values and (3) other undefined reasons. Now, how and where are they displayed?

The dry year requirement value is displayed as the crop irrigation value on both the annual and monthly displays. As in manufacturing the annual value represents gallons per year divided by 365 days per year (even though most irrigation is distributed over 5 to 7 months, not 12).

Either the average year requirement value or the actual estimated use value is displayed on the comparisons page as a part of the total use entitled "Estimated Present Consumptive Use".

If information was available, the actual estimated use value is displayed; if not available, the average requirement value was displayed. (In most cases the average was used.)

4. Steam-Electric--As in irrigation both a dry (80% frequency) and an average year value were developed. The dry year value was developed and displayed only for those ASAs where a significant hydropower capability existed. In these cases the dry year steam-electric demand was larger in a dry year than an average year because in a dry year less hydropower is available and therefore more steam-electric must be provided.

5. Man-Made Evaportaion--The numbers displayed for 1975 evaporation resulted from several different types and sources of data. The unit (per acre) net evaporation rates are those provided by the USGS. The reservoir surface acres for 1975 were derived from various sources. For example, actual evaporation quantities were used when information was available; conservation pool acreages were developed where information could be found and compared with the maximum pool acreages provided by USGS; based upon the comparison, a selection of estimated surface acres was developed and used in conjunction with the USGS unit evaporation rates to get total net evaporation (annual and monthly). Also, farm pond acreages were included to account for evaporation not contained within the estimates of livestock consumption.

   In ASAs where current (1975) annual precipitation exceeds gross evaporation, current evaporation was set to zero. This occurs generally in eastern regions and selected ASAs in the Central and Western United States.

   Evaporation for future years (1985 and 2000) was set equal to the 1975 evaporation rate because of significant problems in estimating a realistic value for the expected change in evaporation.

6. Exports--The values of exports shown are gross exports averaged over the given period. Exports are, per se, 100% consumptive requirements; therefore, they appear in the requirements analysis part of the output rather than being treated as a supply variable. Note that even though there is a net export value there may also be a gross import since it is entirely possible to import water at one location in an ASA and export it from another.

7. Groundwater--Below the net depletion line is a line showing estimated groundwater withdrawals and consumption. The withdrawal figure is the estimated value of withdrawal as derived from USGS 676. The consumption is a gross estimate of how much of the withdrawal is actually consumed and was calculated by multiplying the withdrawal by the ratio of consumption to withdrawal during the given time period (excluding steam-electric). Therefore, the amount of groundwater consumption can vary from year to year even though the withdrawal remains constant due to changes in the consumption/withdrawal ratio. The groundwater consumption estimate is very gross and was not used in determining the changes in instream flows. Rather, groundwater withdrawal was used. Groundwater consumption is used, however, in estimating the surface water consumed in the depletion analysis (See discussion of R & RR ratios below).

8. Import — Below the groundwater figures are given estimates of import withdrawal and consumption. The import withdrawal figures are an estimate of gross import as developed primarily in conjunction with regional sponsors. Like groundwater, the import consumption figures are estimated by multiplying the withdrawal figures by the ratio of consumption to withdrawal for the time period (including steam electric). Again, the import consumption figures are a gross estimate and were not used in estimating future flows but were developed purely for the purpose of estimating surface water consumptive demand for depletion estimates. In estimating changes in flow, the total value of import withdrawal was used.

9. Requirement Ratios — On the right side of the requirements display a set of ratios is shown. The ratios indicate what fraction of the total net depletion each of the functional uses are. These values should be used to indicate where the bulk of the requirements occur, and therefore where impacts of shortages may be likely to occur.

Water Supply and Requirement/Supply Comparisons

As shown in attachment A, display number 5 summarizes the annual and monthly supply information; whereas displays 3 and 4 summarize the requirement/supply comparisons.

The primary utility of the comparison information are twofold:

(1) to obtain an indication of how future projected changes in consumptive uses, import/exports and groundwater withdrawals affect the future streamflow conditions if additional storage were not added. The "R" ratios provide this indicator;

(2) to obtain a realitive indicator of the degree to which the Nation's streams are currently depleted and will be depleted in the future because of current and future levels of consumptive use. The "RR" ratios provide this indicator.

It should be expecially noted that the comparisons presented are not for an ASA; rather they are made for specific points on the Nation's stream system. For example, the comparisons displayed for the outflow point of ASA 1011 do not provide indicators for what is happening in ASA 1011; rather they provide an indication of what will happen to streamflow conditions at that point due to the collective changes in consumptive use, etc., in all upstream ASAs (in the Missouri Region).

Similarly the analysis at the outflow point of ASA 803 represents the effects of the collective changes in the Missouri, Upper Mississippi, Ohio, Tennessee and Lower Mississippi Regions.

In the coastal ASAs there are many rivers flowing into the ocean and therefore the comparisons are not for a point; rather they represent a gross estimate of the overage effect of collective changes in consumptive use on the streams entering the ocean.

The top part of display number 3 shows the total upstream depletions due to consumptive use requirements, evaporation, exports, imports and groundwater withdrawals. Various totals are given including:

- requirements plus evaporation;
- requirements plus evaporation plus exports minus import consumption, and;
- requirements plus evaporation plus exports minus estimated imports and groundwater consumption.

The middle part of display 3 shows the results of striving to reconstruct historical flow conditions and future flow conditions. The bottom part of display 3 shows comparisons of the above flow conditions and total upstream depletions.

The procedures used to obtain these various values and interpretive meaning are discussed in the following.

1. Compution of Future Streamflow Conditions (FMF)--The general equation for determining future streamflow is:

(a) $FMF=PMF+(I_f-I_p)+(GW_f-GW_p)-(C_f-C_p)-(E_f-E_p)-(Ev_f-Ev_p)$

Where FMF is future modified flow, estimated future flow modified by current flow regulation,
PMF is present modified flow,
I is total import,
GW is total groundwater withdrawn (and groundwater is ssumed to be a separate and independent source),
C is total consumptive demand,
E is total export,
Ev is reservoir evaporation,
X_p indicates present value, and
X_f indicates future value.

Using ΔX to indicate change in X, i.e. $\Delta X=X_f-X_p$

(b) $FMF=PMF+\Delta I+\Delta GW)-\Delta C-\Delta E-\Delta Ev$

Note that in this equation, gross values of import and groundwater are used. This gives the initial appearance that a 1 unit increase in import or groundwater will cause a 1 unit increase in streamflow. Apparently, changes in consumption of groundwater and import or the reduction in new groundwater or import due to new consumption are being ignored. This is not the case. As simple as the equation appears, it takes into account changes in consumption efficiencies and consumption of new sources and does so without arbitrary estimation of how consumption is distributed among the three sources. In the following, I will attempt to show why this is so.

Total import and groundwater withdrawals can be broken into two components: that portion of the total withdrawal which is consumed, IC and GWC; and that portion which is not consumed but is released to the stream, IRF and GWRF, (return flow). Therefore:

(c) $I = IC + IRF$

(d) $GW = GWC + GWRF$

Similarly, total consumption can be divided into three portions: Surface water consumption, SWC; import consumption, IC; and groundwater consumption, GWC, depending on which source is used to satisfy the demand. (Obviously, in many cases, imports are discharged directly into and mixed with natural surface flow but, conceptually, they can be considered separately). Therefore:

(e) $C = SWC + IC + GWC$

Export and evaporation losses are assumed to be always satisfied from surface water sources. (Even were this not so, no mathematical difficulties would arise although the following explanation would be substantially complicated).

Substituting the new expressions for import, groundwater, and consumption into the basic equation:

(f) $FMF=PMF+(\Delta IRF+\Delta IC)+(\Delta GWRF+\Delta GWC)-(\Delta SWC+\Delta GWC+\Delta IC)-\Delta E-\Delta EV$

Note that in this equation, we can now cancel out ΔIC, and ΔGWC to give:

(g) $FMF=PMF+\Delta IRF+\Delta GWRF-\Delta SWC-\Delta E-\Delta EV$

Analysis of this equation shows that FMF is calculated by adding to the current streamflow any increase in import or groundwater return flow and subtracting the amount of additional consumptive, export and evaporative demand which must be satisfied from the new streamflows. Note also that it is not necessary to know the values of IC, IRF, GWC, GWRF, or SWC since regardless of their values, they will always be cancelled out automatically.

Basic equation (1), therefore, is a comprehensive analysis of changes in streamflow due to changes in import, groundwater, consumptive, evaporative and export uses.

2. Ratios of Future Streamflow to Current Streamflow Conditions (R)--
The general equation for making this type of comparison is as follows:

$$R1 = \frac{PMF - \Delta C - \Delta EV}{PMF}$$

Which is the ratio of future modified flow to present modified flow due to changes in requirements and evaporation.

In other words this is a ratio of an estimate of the streamflow at a future point in time to the 1975 streamflow. Only changes in consumption and evaporation are considered. Those having R1 give an estimate of the change in the present streamflow due to changes in consumption and evaporation. If R1 is 0.9 for instance, this indicates that the stream will be depleted 10% by increases in either consumptive demand or evaporation (Since evaporation is held constant in all cases R1 refers only to consumption. However, in future studies evaporation may be variable).

R2 - The ratio of future modified flow to present modified flow due to changes in requirements, evaporation, exports, and imports.

$$R2 = \frac{PMF - \Delta C - \Delta EV - \Delta E + \Delta IC}{PMF}$$

R2 reflects changes in the present streamflow due to projected changes in the export-import regime of the area. In the analysis only major changes in export-import were considered such as the Garrison Diversion. Minor changes in export-import values were ignored. However, the value, IC_{jn} is an estimate of the amount of the import which is actually consumed and it will change overtime as the ratio of consumption to withdrawal varies. Therefore, R2 may differ slightly from R1 even though no change in overall export-import is projected.

R3 - The ratio of future modified flow to present modified flow due to changes in requirements, evaporation, exports, imports, and groundwater.

$$R3 = PMF - C - EV + IC + GWC$$

R3 is the most comprehensive of the future depletion ratios. In addition to changes in consumption, evaporation, export and import, it also reflects changes in groundwater withdrawals and consumption. The assumption implicit in this ratio is that if groundwater use increases (decreases) the flows in the stream will increase (decrease) because less (more) water will be taken from surface water sources. However, just because R3 contains a groundwater term, it is not necessarily more accurate. On the contrary, in many cases R3 is less accurate in estimating long-term changes in streamflow. This is because in many cases the stream is fed from groundwater sources and an increase in groundwater use is therefore equivalent to an increase in surface water use. R3 treats groundwater and surface water as independent sources. The cases in which this assumption is true include groundwater mining, deep artesian wells and cases in which the groundwater flow is toward a receiving water such as the ocean. In those cases the groundwater would not outcrop in the surface and, therefore, is actually a separate source.

3. Ratios of Total Depletions Reconstructed Streamflow Conditions (RR)--
The second set of ratios - RR1, RR2 and RR3 - show the impact that the present and future requirements, exports, imports and groundwater have had on the natural flow of the stream. In calculating these ratios a "natural flow" is synthesized by adding the various uses as they were in 1975 to the present modified flow. Thus the effect of requirements plus evaporation is assessed by adding the 1975 actual estimated use and evaporation values to the 1975 flow and dividing the results into the 1975, 1985 and 2000 requirements plus evaporation. Another way to look at it is to consider RR1, RR2 and RR3 as showing the fraction of the requirements to the supply which would be available if the requirements did not exist.

RR1 - Ratio of depletion due to requirements and evaporation.

$$RR1 = \frac{C_F + EV_F}{PMF + USE_P + EV_P}$$

RR1 is the ratio of the consumptive and evaporative uses to the flow which historically would have occurred if there were no consumptive or evaporative uses. The denominator is the reconstructed "natural" flow estimated by adding back in to the 1975 flow the sum of estimated 1975 actual consumptive uses and evaporations. RR1 might be considered to be a ratio of the consumptive and evaporative use to the available surface supply. If, for instance, RR1 is 0.10, then this implies that only 10% of the available surface supply is being used. Conversely, it indicates that the stream is now flowing at 90% of its historical flow and hence has been 10% depleted.

RR2 - Ratio of depletion due to requirements, evaporation, exports, and imports.

$$RR2 = \frac{C_F + EV_F + E_F - IC_F}{PMF + USE_P + EV_P + E_P - I_P}$$

RR2 is a more comprehensive representation of depletion than RR1 in that the effects of changes in the import-export scheme for the area are included. In most cases RR2 is the most accurate representation of the actual depletion in the area. Export in particular is a consumptive use which is invariably satisfied from surface water sources. Therefore, to reconstruct the historic flow the amount of this export should be added back to the flow. Similarly, some of the present flow in the stream is due to imported waters and these imports should be subtracted out of the flow. In the numerator the surface water demand is estimated as the sum of the consumptive, evaporative and export requirements minus the estimated amount of requirement satisfied by the imports.

RR3 - Ratio of depletion due to requirements, evaporation, exports, imports and groundwater.

$$RR3 = \frac{C_F + EV_F + E_F - IC_F - GWC_F}{PMF + USE + EV_P + E_P - I_P - GW_P}$$

The final depletion estimate, RR3, includes groundwater uses in addition to the other uses. As in R3, there is an implicit assumption that the groundwater and surface water sources are independent. In many cases this will not be so and RR2 will be the proper ratio. In constructing the surface water demand in the numerator, the estimated amount of consumption that is satisfied from groundwater is subtracted from the consumptive demand. In reconstructing the historical flow the total groundwater withdrawal is subtracted from the present flow.

Notes on the Behavior of RR Ratios

The RR ratios are the ratios of estimated surface demand to the estimated historical surface flow. As such, it is apparent that the RR ratio should not be greater than 1 or less than 0. If this is the case, it implies that more water is being used than is available, a logical contradiction. Nevertheless, negative RR ratios and RR ratios in excess of 1 do appear in the results of the analysis and the reason for this should be discussed. As an example, the RR3 ratio will be used, although the same applies also to RR1 and RR2. The RR3 equation is:

$$RR3 = \frac{C_F + EV_F + E_F - IC_F - GWC_F}{PMF + USE + EV_P + E_P - I_P - GW_P}$$

In the volumetric model restraints are placed on the estimates of import consumption, IC, and groundwater consumption, GWC, such that the sum of these can never exceed the total requirement, C.

The evaporation, EV, is also constrained never to be negative on an annual basis, although some monthly values may be negative. The exports can never be negative or they would be treated as imports. Therefore, the numerator of the equation can never be less than 0 (except in the unusual case where the evaporation is negative, and this can never occur in an annual analysis).

The difficulty arises in the denominator. The values of the present modified flow, export, import, and groundwater are all independent estimates. Since these values are given in the data, they cannot be constrained, but must be taken as they are. Therefore, when import and groundwater are subtracted from the sum of PMF, USE, and EV, it is possible for the result to come out zero or even less than zero. A value of RR3 (or RR1 or RR2) greater than 1 indicates that the estimated natural flow is less than the estimated use. A value of RR3 (or RR1 or RR2) less than 0 (negative) indicates that the estimated natural flow is negative. Both cases are logically impossible and are the result of errors in estimating the the flow, use, import-export or groundwater.

The behavior of the ratios can best be described by referring to Figure 1. As this figure shows, the RR ratio behaves like a hyperbola. As the natural modified flow, NMF, decreases, the value

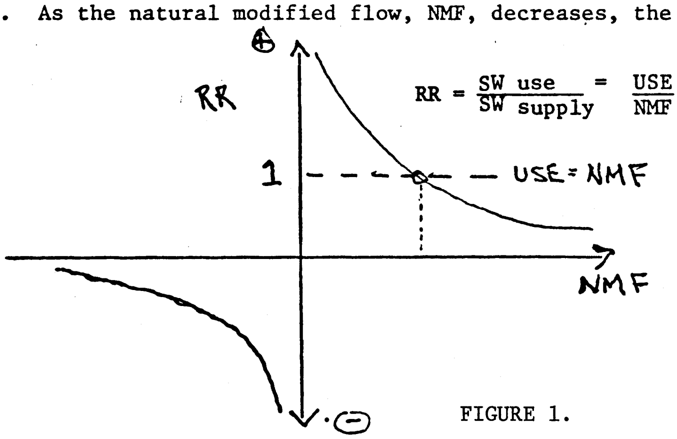

FIGURE 1.

of the RR ratio increases until the NMF reaches 0 where RR = ∞. At this point the trend reverses and the absolute value of RR decreases with decreasing NMF. Therefore, a large negative RR ratio indicates that the NMF is nearly zero, while a small negative RR ratio indicates that the NMF is much less than zero. Thus the conclusion is that a very large negative RR ratio is a better estimate than a very small RR ratio.

Finally, it should be pointed out that the anomalies in the RR ratio are the result of inaccuracies in the estimation of the data and not in the mathematical handling of the data. Therefore, better estimates of the data will result in better results in the future.

CONFLICTS WITH PRIVATE AND FEDERAL USERS

Richard J. Dauber
Assistant Regional Solicitor
Department of the Interior
Sacramento, California 95825

ABSTRACT

The subject of this presentation is "Conflicts With Private and Federal Users." Increases in municipal and industrial demands, agricultural demands, and environmental demands have created conflicts with instream uses of water which water developers and users did not envision fifteen to twenty years ago when the water development agencies were in the process of making their studies in order to recommend water development programs both federal and state.

These conflicting demands have resulted in a number of lawsuits, the ultimate resolution of which could conceivably change the entire water development program throughout the western United States. These lawsuits not only seek to establish priorities for the use of instream water but also to establish who will control the use of such water. In this connection a landmark case presently pending in the United States Court of Appeals for the Ninth Circuit entitled *United States* v. *The State of California* *ex*. *rel*. *State Water Resources Control Board*, will be discussed herein in detail.

INTRODUCTION

The Reclamation Act of June 17, 1902, 43 U.S.C. §§ 391 *et seq*., created a fund from the sale and disposal of public lands in certain states and territories to be used in the examination of and survey for and the construction and maintenance of irrigation works for the storage, diversion, and development of water for the reclamation of arid and semiarid lands in the states and territories. It was by this Act that the Reclamation Service later to be called the Bureau of Reclamation was created and the many reclamation projects throughout the seventeen western states were developed and constructed.

Section 8 of the Reclamation Act of June 17, 1902, 43 U.S.C. §§ 372, 383 provides: "Nothing in this Act shall be construed as affecting or intended to affect or to in any way interfere with the laws of any state or territory relating to the control, appropriation, use, or distribution of water used in irrigation or any vested right acquired thereunder and the Secretary of the Interior, in carrying out the provisions of this Act, shall proceed in conformity with such laws and nothing herein shall in any way affect any right of any state or of the Federal Government or of any landowner, appropriator, or user of water in, to, or from any interstate stream or the waters thereof."

Although this provision of the law is some seventy-four years old, there are surprisingly few reported legal decisions interpreting its meaning. This is particularly noteworthy since it directly affects the relationship between Federal Reclamation projects and the water rights of private and public appropriators and water for fish and wildlife, environmental, and other purposes. The meaning of this section of the law according to the states was crystal clear. According to the interpretation of this section by the state interests, it meant that the Federal Government was to acquire water rights in accordance with state law and that once the reclamation project was built the Federal Government was to deliver the project water under state law and that state law would determine when and to whom the project water would be distributed. Thus, the states felt that Section 8 placed a statutory limitation on the Supremacy Clause of the United States Constitution which makes federal laws supreme over conflicting state laws. On the other hand, the Federal Government interpreted Section 8 as basically requiring the United States to recognize vested water rights obtained under state law in carrying out the provisions of the Act. The interpretation of this provision was first placed in issue in the case entitled Ivanhoe Irrigation District v. McCracken, 357 U.S. 275. In this case the question arose as to the validity of imposing acreage limitation provisions of Reclamation law upon the users of the federal water developed by the Friant Dam in the Central Valley Project of California. In the validation proceedings involving the contract between the Ivanhoe Irrigation District and the United States, the Supreme Court of the State of California determined that the acreage limitation provisions of Reclamation law requiring an individual to dispose of all but 160 acres in order to obtain water was in conflict with state law and, therefore, was an invalid imposition of law under the contract. The matter was appealed to the United States Supreme Court, which stated that Section 8 of the 1902 Act does not override the excess land provisions of Section 5 nor does it compel the United States to deliver water on conditions imposed by the state. It merely requires the United States to comply with state law when in the construction and operation of a Reclamation project it becomes necessary for it to acquire water rights or vested interests therein. It went on to state that the acquisition of water rights must not be confused with the operation of the federal projects. Another Supreme Court case interpreting Section 8 is the City of Fresno v. California, 372 U.S. 627. This case was decided in 1963 and was a companion case to the case entitled Dugan v. Rank. This case, too, involved the operation of the Friant Dam on the San Joaquin River, which is a keystone of the Central Valley Project. In this case the parties sought to require the Bureau of Reclamation to release certain waters from the Dam and to operate the Dam in a certain manner so as to assure the plaintiffs would receive water pursuant to their water rights vested under state law. The District Court held that it had jurisdiction to hear the matter and to determine an operating criteria for the Federal project. The Supreme Court of the United States ruled that Section 8 of the Reclamation Act does not mean that state law may operate to prevent the United States from exercising the power of eminent domain to acquire water rights of others. Rather, the effect of Section 8 in such a case is to leave to state law the definition of the property interests, if any, for which compensation must be paid. In another case decided in 1963 entitled Arizona v. California, 373 U.S. 546, the Supreme Court ruled that where the Government has exercised its right to regulate and develop the Colorado River and has undertaken a comprehensive project for the improvement of the River and for the orderly and beneficial distribution of water, there is no room for inconsistent state laws. So it can be seen from these cases that the advocates of state control over Federal Reclamation projects received a severe setback in the form of these Supreme Court decisions. Basically, these decisions state that Section 8 should be read as requiring the United States to recognize rights vested under state law; however, that the states cannot dictate the method of operation of a Federal project where the project has been duly authorized by Congress.

The question came into sharp focus in the State of California. The Central Valley Project of California is one of the largest reclamation projects in the United States. The Project involves a complex series of dams and canals on the Sacramento River, the American River, and the San Joaquin River as well as impoundments on various tributaries thereto. The water from the San Joaquin River which is impounded behind Friant Dam near Fresno, California, is diverted from the river channel to serve agricultural lands in Madera County, California and in the southerly portion of the San Joaquin Valley. Water from the Sacramento River in Northern California is taken from the Sacramento-San Joaquin Delta to the San Joaquin Valley, both for irrigation purposes and to satisfy rights on the lower San Joaquin River which were interfered with by the construction of the Friant Dam. Because of the increased environmental concerns in the United States, the question of diversions of Federal Reclamation water from the Sacramento-San Joaquin Delta has been a matter of increasing concern and conflict. The United States, in acquiring its water rights for the vast Central Valley Project, always has applied to the State Water Resources Control Board and its predecessor, the State Water Rights Board, for water rights permits. At the same time, Bureau representatives maintained that the applications were only filed in the interest of comity and for orderly administration of the states' waters. Until recent years such permits were issued routinely after a determination that unappropriated water was available. Recently, however, because of environmental concerns and other incidental reasons, the State Water Resources Control Board has undertaken to condition permits issued to the United States with conditions that affect the ability of the United States to impound water on the Sacramento and American Rivers and to divert from the Delta. The initial water rights permits on the Sacramento River and for diversion from the Sacramento-San Joaquin Delta were granted to the United States in what is known as Decision D-990 by the State Water Board adopted on February 9, 1961. This Decision purported to reserve jurisdiction to the Board to include terms and conditions in the permits relative to salinity control in the Sacramento-San Joaquin Delta and to coordinate terms and conditions in these permits with permits issued to the State of California, Department of Water Resources, for the State Water Project. The reservation also purported to reserve jurisdiction to include terms and conditions for the protection of fish and wildlife in the Delta. After an extended hearing before the Board in which all interested parties participated, the Board issued what is known as Decision D-1379, adopted July 28, 1971, which purported to condition Bureau permits with respect to storage and diversion of water under the permits previously issued. The conditions provided in essence that the Bureau would be prohibited from impounding or diverting water during a period of time when certain salinity conditions were not met in the Sacramento-San Joaquin Delta. This, of course, included surplus waters stored during periods of high flows which would not have been in the Delta to divert had it not been for the Bureau project. Soon after this Decision was rendered the Board also had a hearing on the permits issued for the Auburn Unit of the Central Valley Project and the Board conditioned these permits upon the maintenance of certain flows in the Lower American River for fish and wildlife and recreation purposes. These flows likewise would not be available in the river during summer months absent the project. Finally, a third Decision was rendered by the Board on the New Melones Project which was being constructed by the Corps of Engineers but was to be integrated into the Central Valley Project and operated by the Bureau of Reclamation. In this last Decision the Board placed specific conditions upon the operation of the project itself, providing, among other things, that the reservoir could not be filled until further hearings and orders by the Board contrary to the authorizing legislation. In each instance the Board relied upon state law which,it held, gave the Board the right to include in the public interest terms and conditions affecting the operation of the project. In each of the Decisions the United States advised the Board that it was the position of the United States that the Board had no authority to condition permits issued to the United States and that the only duty on the Board was to determine whether or not unappropriated water was available for the Federal project and, if so, to issue the water rights permits. The Board, because of its stated position, filed a suit against the United States asking for a declarative judgment that it could so condition Bureau permits. The United States of America then brought the case of United States v. The State of California ex rel. State Water Resources Control Board, S-3014, United States District Court, Eastern District of California. The suit was similar to the state suit but more specific in asking for a declaratory judgment that the State of California had no right to condition permits issued to the United States for the New Melones Project. The legal questions were briefed by both parties and the State of California moved for a summary judgment determining that the State did in fact have the right to condition Bureau permits. The District Court entered judgment on October 9, 1975, determining: (1) the United States can appropriate unappropriated water necessary for any Federal Reclamation project in California but must first, in accordance with comity, apply to the State Board for a determination of availability of unappropriated water; (2) the Board must grant such applications if unappropriated waters are available; (3) there are no existing Federal laws, regulations, or administrative directives allowing the Board to impose any terms or conditions in permits issued to the United States as a result of applications to the Board for unappropriated water; (4) the Decision placing terms and conditions upon permits issued to the United States for the New Melones Dam and Reservoir is void in all respects as said terms may relate to the control, development, or operation by the Federal Government of the New Melones Project. As I have stated, this case has been appealed by the State to the Ninth Circuit Court of Appeals. This Decision is an extremely significant Decision and its ultimate outcome will affect water rights and control of inbasin and instream water throughout the seventeen western states in which the Bureau of Reclamation has or is constructing Federal Reclamation projects.

In summary, the status of the law today in the Eastern District of California subject to the determination by the Ninth Circuit Court of Appeals is that the respective states have no control whatsoever over Federal Reclamation projects and that if the Bureau of Reclamation chooses to apply to the states for water rights, the states must determine if unappropriated water is available and, if so, to issue water rights permits without restrictions.

It should be pointed out, however, that the Flood Control Act of 1944 requires state comments on proposed Federal projects and that it is extremely unlikely that Congress will ever authorize a project which is not supported by the involved state.

Turning now to utilization of water by private individuals or water districts, we find that the use by individuals or by districts of the recently enacted National Environmental Policy Act of 1971 has given these parties a powerful tool in determining the use of water developed by Federal Reclamation projects. There is presently pending in the United States District Court in the Northern District of California the case entitled Contra Costa County Water District v. Kleppe, Civil No. C-75-2508-SW, in which the Contra Costa County Water District seeks to enjoin the Secretary of the Interior from executing or performing a proposed contract with the Westlands Water District for delivery of Central Valley Project water to that District. The Contra Costa County Water District is a district which contracts for and receives water from the United States of America and is located within the area known as the Sacramento-San Joaquin Delta. The Westlands Water District is a district consisting of some 600,000 acres located on the west side of the San Joaquin Valley in Fresno, Merced, and Kings Counties, California. It is proposed to deliver some one million acre-feet of water from the Delta to the Westlands Water District pursuant to contract entered into under Reclamation law. Millions of dollars have been spent for the necessary facilities to deliver the water to the Westlands Water District. The Contra Costa County Water District seeks to enjoin the Secretary from executing a contract with the Westlands Water District on the grounds that the Department of the Interior has not complied with the National Environmental Policy Act and that unless the execution of the contract is enjoined irreparable damage will result to the Sacramento-San Joaquin Delta, thus resulting in damage to the Contra Costa County Water District. Thus, we see that the National Environmental Policy Act is being utilized and undoubtedly will be utilized in the future in an effort to influence the operation of Federal water development projects.

In closing I would like to quickly sum up the message which I hope that

I have conveyed to you today. Water development programs in the Western United States are in jeopardy. It would appear to me that if the various states are successful in their attempts to obtain control of the operation of Federal projects that Congress will be extremely reluctant to authorize future projects which I believe are vitally needed to continue to furnish the people of the United States with water for agricultural, municipal, and industrial uses, clean hydroelectric power, year-around stream flows for environmental and recreational purposes, and other incidental needs. Further, the utilization of the National Environmental Policy Act of 1971 by individuals, environmental groups, or other water districts to delay water development projects or to affect the utility of such projects could also lead to a lack of Congressional authorization for such projects. Certainly each delay created by such litigation creates an additional strain upon the Federal budget which Congress may be unwilling to accept. It is my opinion that these problems must be solved by full cooperative efforts on the part of federal, state, and local governments and individuals rather than by time and cost-consuming litigation.

TOPIC I-B.

RECOGNITION OF IFN IN CHANGING TIMES

Summary Discussion

The following responses were offered to the initial question regarding crucial research needs:

1. The variety of dimensions in the conflict and methods of implementation.

2. Assessing priorities so that resources can be put where they can be most productive.

3. Ways in which development features, such as canals, can be used and managed as fish habitats.

4. Organizational change. Learning to plan with excess information in an era of turbulence; modeling uncertainty.

Most of the discussion was directed to the legal parameters of the instream flow arena:

1. There is some latitude for administrative discretion in project operation to provide instream flows, within the context of legislative authorization. However, in some cases, the most effective means of protecting instream flows below existing projects is restudy and reauthorization of the project by Congress to include fish and wildlife as project purposes. More recent projects generally allow more administrative discretion than earlier projects where fish and wildlife were not yet effectively recognized.

2. If project operations do not maintain specified minimum flows, there probably is some legal means of obtaining relief, but more detail was not provided in the discussion.

3. One important method of obtaining flows is joint planning and accommodation on the part of all water users--traditional water users and instream flow interests. They may result in more positive action than litigation, which examines only narrow legal questions in the context of adversary relationships.

4. More consideration must be given the surface water/groundwater interface because of the close relationship between groundwater (recharge and supply) and streamflows.

Notes by panel moderator: Harvey R. Doerksen
Steering Committee Member

WHY ARE ENERGY WATER NEEDS DIFFERENT?

Raphael J. Moses
Attorney at Law
Boulder, CO

ABSTRACT

Although, generally speaking, there is sufficient water for energy production, the location of some instream uses may cause severe increase in the price of the product. In most cases of instream use above the point where water is needed for energy production, energy companies will not be adversely affected. However, downstream commitments for instream use may severely handicap energy production. Decisions on the location and amount of instream uses are made without adequate public knowledge of the impact of such decision-making, and little opportunity is afforded for intelligent choices between lower-cost energy or preservation of instream values.

Although it may seem somewhat far afield from a discussion of instream flow needs, and the impact of those needs on water requirements for energy production, a brief overview of the general requirements of water for energy may be helpful. There are several schools of thought on the question: "Why are energy needs different?"

One school of thought is that most of the rivers of the West are bankrupt and that there is insufficient water for projected energy needs. We will call that the Doomsday School of Thought.

At the other end of the spectrum is the school of thought that believes, because there has not yet been a shortage of water for energy, that there will never be such a shortage. This, obviously, is the Pollyanna School of Thought.

I would not be very comfortable with a degree from either of these schools. The true situation lies somewhere in between.

The excellent report of the Western States Water Council entitled "Western States Water Requirements for Energy Development to 1990," reaches, <u>inter alia</u>, the following conclusions:

> Water demands to support the energy industry in the West will be large...The amount of water needed can be varied by administrative decisions. Wise planning and prudent administrative choices could greatly reduce the demands for water for energy and soften the impacts on water short areas.
>
> Most uses of water cannot compete economically with the energy industry in paying the cost of water. To allow the energy industry

to acquire water rights at the market place, could result in the new allocation of limited waters to energy while reshaping established economies with perhaps locally the greatest impact being on irrigated agriculture.

Environmental laws and results and regulations that do not allow for flexibility in choosing the best solution at given sites, could result in large wastes of water and could result in greater environmental damages.

The report summarizes (see Table 1) the estimated increased water required to meet growth in energy needs in the eleven Western States to 1990.

TABLE 1.

State	Coal fired power plant	Nuclear power plant	Oil shale	Coal mining	Coal gasification	Coal slurry	Geothermal	Other energy processes	Total
Arizona	75	73	0	10	11	0	0	2	171
California	81	276	0	0	0	0	22	13	392
Colorado	90	14	260	10	11	0	0	2	387
Idaho	30	9	0	0	0	0	4	0	43
Montana	124	0	0	70	44	40	0	1	279
Nevada	41	0	0	0	0	0	2	0	43
New Mexico	20	0	0	3	72	0	2	1	98
Oregon	18	122	0	0	0	0	4	0	144
Utah	120	0	40	42	11	0	0	3	216
Washington	0	126	0	0	0	0	0	0	126
Wyoming	118	0	20	60	44	160	0	3	405
								Total	2,304

California has, as you will observe, the largest single requirement for a single kind of energy requirement--that of 276,000 acre-feet of water for nuclear power plants. The Western States Water Council report does not indicate how much of this water could come from ocean water, and thus reduce the impact on surface water rights. Nor does the report reflect the use of return flows from irrigation as a water supply, such as is presently proposed in the Palo Verde area for the Sun Desert plant in connection with two 950 mw units. Obviously, the use of return flows from irrigation, if they are not already committed to other vested rights, likewise reduces the impact on uncommitted water. The Palo Verde return flows, it should be noted, do not come within this category, as these flows now go back to the Colorado River, where they are utilized downstream.

I would like to address myself to the Colorado situation, that being one with which I have some familiarity. I suspect that, in the eleven western states, Colorado would rank about third in water scarcity, and one where the combination of scarcity of water and contemplated demand creates a problem equal to, if not greater than, that of any other western state.

The Colorado River drainage in Colorado, in turn, presents what is probably the most critical area in Colorado.

So far as Colorado is concerned, in the first Cameron-Jones study of water requirements for oil shale, made in July of 1959, the needs were estimated at 250,000 acre-feet for a production of 1,250,000 bbl/day. As you can see, this estimate is not too far from the conclusions reached by the Western States Water Council.

Felix L. Sparks, long-time director of the Colorado Water Conservation Board, and one of the leading authorities on the Colorado River, made the assessment, shown in Table 2, of the situation on the Colorado in 1965.

Has anything occurred since that appraisal was made to change the situation? I believe two influences have been at work which may make the picture a little less gloomy.

First, some of the energy companies have acquired their own water supplies by purchasing old water rights and converting them from irrigation to industrial use. This may not be a realistic solution in some of the other states because of inadequate institutional methods of effectuating such a change. The wisdom of taking agricultural land out of production in order to provide water for energy needs is a question stimulating considerably more debate than it did ten or twenty years ago, when many of these rights were acquired.

COLORADO RIVER BASIN
ESTIMATED POTENTIAL DEPLETIONS CHARGEABLE TO COLORADO
(Subject to Adjustment)
Units - 1,000 Acre Feet

Project	Oil Shale	Total Irrig., M&I, & Res. Evap.	Accum. Total
Total-Present, Authorized & Committed			2,720
*Animas-La Plata		93	2,813
*Dolores		74	2,887
*Dallas Creek		37	2,924
*West Divide	44	71	2,995
*San Miguel		74	3,069
*Yellow Jacket	32	57	3,126
Battlement Mesa		11	3,137
*Bluestone	10	13	3,150
*Grand Mesa		32	3,182
*Upper Gunnison (Including Tomichi Creek, East River & Ohio Creek)		22	3,204
Basalt		26	3,230
*Juniper (Including Great Northern)		97	3,327
Middle Park (Including Troublesome & Rabbit Ear)		29	3,356
*Four Counties Export - Yampa		40	3,396
*Potential Oil Shale Uses	64	64	3,460
*Potential Transmountain Diversions		130	3,590

*Includes Municipal and Industrial Water.

Colorado allocation by Upper Basin Compact: 7,450 x 51.75% = 3,855.
Available supply re Tipton Report: 6,250 x 51.75% = 3,234.

Environmental restraint may render some of the anticipated developments uneconomical. In orders, sheer inability to obtain necessary federal rights of way, again for environmental reasons, make some of the anticipated developments impossible. Ask any member of the Denver Water Board what effect the inclusion of a major portion of its proposed Eagle-Piney project in a wilderness area has on the economics of that plan. The last I heard, some half billion dollars had been added to the cost by congressional approval of an enlarged Gore Creek Wilderness area.

Colorado Springs and Aurora, two cities in Colorado, joined to construct the Homestake Project, which takes water from a tributary of the Colorado through a tunnel to the Eastern Slope of the Continental Divide, and outside the Colorado River Drainage. The first phase, built by conventional methods, was completed about five years ago. The cities have now been advised that no roads will be permitted in the construction of the planned second phase of the porject, and that all supplies and equipment will have to be helicoptered in. Because of the enormous cost increase resulting from this decision, the second phase has been postponed indefinitely.

There is, however, a more simplistic approach. Ninety percent of the water diverted in Colorado is used for agriculture. If more efficient methods of diversion, transportation and use could save 11 percent of that amount of water, twice as much water could be made available for non-agricultural uses, including production of energy. I am neither an agronomist nor an expert in irrigation efficiency, but I find it difficult to believe that 11 percent of the water diverted for agriculture is not wasted by either inefficient diversions, inefficient conveyance systems or applications of irrigation at other than an optimum rate or a combination of two or three of these inefficient practices.

I have been preaching this sermon for many years, without getting through to very many of my parishioners, so I was comforted by the remarks of Dr. Daniel A. Dreyfus, Deputy Staff Director, Committee on Interior and Insular Affairs of the United States Senate, before the National Capitol Section of the American Water Resources Association on September 18, 1975, entitled "Water Resources for Energy Self-Sufficiency" where he said:

> In the Colorado Basin, about 90 percent of all existing water uses are for agriculture, much of it inefficiently applied and producing low value crops. Water for new energy uses quite probably will come, in part, from purchases of existing agricultural rights rather than the development of new supplies.

With this admittedly cursory assessment of water availability, let us now turn to the matter at hand--the effects of instream decrees on energy development.

First, let us consider instream decrees for national forests. In the overwhelming majority of such situations, particularly when such instream uses are to support cold water fish habitat, such uses are compatible with energy developments which, in the case of coal fired electric generating stations, coal gasification plants and oil shale developments are, almost without exception, located below forest boundaries. Instream uses tend to preserve the flows in the mountains so that they will be available below the boundaries for any type of beneficial use. Such instream uses do not, in my opinion, pose a significant problem for energy development.

The reservation of large quantities of water in lower reaches of our highly erratic streams for such purposes as river rafting, as is proposed by the United States in the reach of the Yampa River in Dinosaur National Monument in Colorado, is quite a different matter. Any such reservation inhibits energy development upstream, and the greater the reservation, the less development of energy upstream.

Dinosaur National Monument was established in 1915 and the government seeks a decree with this priority date. Only recently has "running the river" developed much of a constituency, but it is big business now. As one who has enjoyed a so-called "float" trip on the Green, I have some sympathy for the desire to maintain reasonably high flows for this purpose.

My chief concern is that an irrevocable allocation of a valuable resource may be made without adequate public input. The decision to seek an arbitrary minimum flow of 1,000 second feet in the Yampa in the critical low-flow period was a unilateral one made by the National Park Service, without consultation with the public and without the public understanding the cost-benefit ratio involved or the benefits foregone in order to satisfy a perfectly legitimate demand by a very small, relatively speaking, percentage of the people affected.

Water rights existing at the time of the institution of the instream use are property rights, and, under our various state constitutions and the federal constitution, must be protected. They cannot be taken without compensation. In Colorado, for example, the statute authorizing the Colorado Water Conservation Board to make instream minimum stream flow appropriations (after consultation with the Division of Fish and Wildlife) expressly prohibits the taking of existing rights by condemnation.

It is the new appropriations for energy needs that are adversely affected by downstream instream use requirements. There is simply less water to appropriate. When the lesser supply is exhausted, the cost of water for energy escalates sharply, and may, in streams like the Yampa, become prohibitive.

Can energy companies adapt to this new restriction on available supply? My answer is an extremely qualified "yes". Let me explain.

In fairness, it should be stated that in the very capital intensive field of energy development, the acquisition of a water supply is a minor portion of the total. However, if environmental constraints make water unavailable, relocation of a facility far from the source of raw materials may create a major increase in the cost of the product.

If the amounts allocated to instream use are reasonable and modest--and I know how subjective the definitions of "reasonable" and "modest" can be--the impact will not be too severe. Unilateral decisions by agencies with built-in prejudices, albeit well-intentioned, are apt to be neither reasonable nor modest. No state or federal officeholder, whether elected or appointed, wants to be guilty of not having set aside enough water for the instream use contemplated. Therefore if he is to err, it will be on the side of allocating too much.

Again assuming the amounts of instream commitments to be reasonable and modest, energy producers can accommodate although the methods of accommodation are expensive.

One method is by acquisition of water rights which are senior in priority to the instream use right. This potential is limited by the availability of senior rights and also by the impact on the agricultural economy. Removing a substantial part of the agricultural economy of a relatively small area may create social and political problems which the energy producer may decide are intolerable even though economically feasible.

The second method is by the construction of sufficient upstream storage to provide the water for energy development and, in addition, to provide water for releases to maintain the instream use requirement. This method is even more expensive.

There is no magic in this business. If water costs rise sharply, the money can come from only one source--the consumer. And, as of the moment, the consumer has no voice in the decision.

The agency, whether state or federal, has issued no environmental impact statement, and the average consumer knows about the decision only after the fact. Even in my beloved Colorado, where the Water Conservation Board makes the decisions after open discussion, there is minimal notice to the man who pays the utility bills, and the Public Utilities Commission authorizes rate increases after the added costs have been incurred and cannot, either legally or morally, prevent the utility from recouping costs arising out of the need to observe environmental quality.

As little enamored as I am of the cumbersome environmental impact statement procedure, for the public to make a choice between water for river running and water for energy, that public must know the tradeoffs and then, and only then, can it make an informed, educated choice. I, for one, can live with such a decision, and, I dare say, energy companies can, too.

Thank you.

THE VIEW FROM FOUR LEGAL CORNERS
(THE INDIAN CORNER)

James B. Hovis
Attorney
Hovis, Cockrill & Roy
Yakima, WA 98904

ABSTRACT

Waters arising on, traversing, or bordering Indian reservations are reserved for the beneficial use of the Indian people on said reservations. This is called the Winters or Reservation Doctrine. These waters are not open to appropriation or acquisition under state law. For the best interests of everyone, Indian reservations should be developed to fully use their water in order to properly plan for and fully utilize the resource.

In the arid west, nothing, with the possible exception of one's wife and children, is more sacrosanct than one's water or right to water. This is also true in Indian country. The Southwest bears testimony to the practice of irrigation by Indians even in ancient times and the pre-treaty Indian diversion of Ahtanum Creek on the Yakima Reservation is often called "the cradle of irrigation" in the State of Washington. It is well recognized in the negotiation of treaties with western tribes, that if the Indians were to cede the vast areas that they used to provide for their livelihood in a food gathering culture, then a more intensive use of the reserved lands would have to be made. In the negotiation of these treaties and in order cession of vast Indian holdings, promises were made of assistance by the United States in creating a viable Indian community on these limited reservations so that the Indian people could live in economic parity with their white neighbors. Likewise, implicit in the enactment of the General Allotment Act and other allotting acts, was the promise that these allotments would be developed so as to provide the Indian people with economic parity. Over the course of these years, it has been a noticed fact by all branches of the Federal Government that the barren wastes of hot scorching lands comprising most western reservations are uneconomic without water. It is a similarly noticed fact that even where there is no shortage of rainfall that the proper use of waters for fish production and other uses is necessary to make Indian reservations viable communities. "Our land without water is like a body without blood" is an Indian statement often repeated that describes it all in a very few words.

In recognition of these promises, negotiations, and noticed facts, the Supreme Court has enunciated the reservation (Winters) doctrine. This doctrine holds that waters which arise on, border or traverse Indian reservations are reserved for the Indian people within those reservations. These waters are reserved for the beneficial use of the Indian people in order for them to maintain the promised viable Indian community within the lands reserved. The principle case enunciating this doctrine is Winters v. United States, 208 U.S. 564 (1908). This treaty right to maintain a viable community within the lands reserved is likewise extended to executive order reservations as well as treaty reservations. (Arizona v. California, 373 U.S. 546) (1963). Further, in specific terms it has been judicially decreed that the Indian's use of the waters is not open to appropriation or acquisition under state law. United States v. Ahtanum Irrigation District, 236 F. 2d 331 CA9, 1956), 330 F. 2d 897 (1965). It therefore logically follows that where the Indians have a right to these waters that the waters should come to them on their reservation in such a condition that they can beneficially use them. The right to quantity must necessarily contain a right to quality.

It would seem that now that this right has been clearly defined that it would appear that for proper planning and management, that the basic needs of the Indians should be served so that excess or return flow waters can be otherwise utilized in the reservation areas. Then why, I must ask, with this clear doctrine and the beautiful statements of the executive and legislative branches of the Federal Government that recognize these basic needs and promises, are the Indian people sitting so dry on their limited reservations? This situation neither serves the Indian people or their neighbors who need to plan in regards to water use. The governments first venture in irrigation construction for Indian people was provided in 1867 by the appropriation for funds for the construction of a canal for irrigating the Colorado Indian Reservation in Arizona. Today, in spite of this early start, there have been less than 20 major Indian irrigation projects started. Today, over one hundred years after this first cultivation, there are less than one million acres under cultivation on Indian reservations. Even among some of the so called Indian irrigation projects, up to 95 percent of the lands irrigated by these projects are non-Indian owned.

I note that in the state where I was born, that almost one million acres of land have been put into cultivation off reservations since my birth. While this is true in regards to off-reservation projects, projects that were proposed on the Yakima Indian Reservation prior to my birth are still languishing, yet to be completed.

It is not only in the situation as regards construction of projects for the development of this area that I find fault with the federal government, but it is likewise in the question of regulation of waters within the reservation. In the General Allotment Act, Section 7, the Congress of the United States in 1887 told the Secretary of Interior that he was to prepare regulations where necessary to allocate the water among the Indians upon the reservation. It has been almost ninety years since the Secretary of Interior was given that direction. However, because of the hot political consequences and problems involved in the allocation, the Secretary has yet to promulgate regulations to regulate the water within the reservations. Not only has he failed to live up to his responsibility, but he has given orders that the tribes themselves are not to pass regulations allocating their water and are not to have a water code on their reservations. All of this doubt and confusion, whether it has to do with the construction problem or the regulation problem, does not benefit either the Indian or non-Indian community. For us to properly use this most precious water in our western lands, we must definitely know where we are going and what use can be made of those waters. The law is there, all we need to do is to have the proper approach under it.

A STATE DEPARTMENT OF FISH AND GAME'S LEGAL VIEW AND TECHNIQUES FOR ACHIEVING INSTREAM FLOW GUARANTEES FOR FISH AND WILDLIFE PURPOSES

Denis Smaage
State of California
Department of Justice
Sacramento, California

For many years the California Department of Fish and Game has been contesting at all levels those who would divert water out of streams to achieve the one goal of retaining guaranteed flows instream for preservation of fishery and wildlife resources. The department's adversaries range from such federal agencies as the United States Corps of Engineers and United States Bureau of Reclamation on through California state water projects, local flood control and irrigation districts and down to the individual city diverters and individual farmers. These contests have focused around California water law. It is therefore proper to briefly explain the California appropriative water rights system.

Pursuant to statute California has provided that anyone may apply for and appropriate water if the applicant can show that there is 1) unappropriated water available out of a given stream, 2) that he intends to put it to a beneficial use, and 3) he has the physical and financial wherewithal to accomplish his project within a reasonable time. Such an applicant must apply to the State Water Resources Control Board, which is an agency of the State of California set up to regulate the creation of water rights to unappropriated water. This Board has no authority over riparian rights and it only passes on applications for water to which no other persons have claimed rights, that is, unappropriated water. This Board holds formal hearings upon each application that is protested and provides the forum wherein the Department of Fish and Game has found itself most frequently as a protestant defending the right of the People to have certain amounts of water set aside for instream uses. This arises due to the fact that under the California Water Code the Department of Fish and Game has a right to file a protest and seek conditions upon any water permit that may be granted by the Board. The conditions proposed by the Department of Fish and Game usually if not always include specified minimum flows for the protection and preservation of existing fishery resources that may be adversely affected by the project. Through this device the Department of Fish and Game has been successful in imposing significant minimum flows in major projects such as the Auburn-Folsom Project on the American River wherein a minimum flow of 1500 cubic feet per second was guaranteed in the American River. This flow was for purposes of maintaining a very significant King Salmon run in the neighborhood of 50,000 adults annually, a Steelhead run, and also for Shad, Striped Bass and recreational purposes since the river is used a great deal by rafters.

This technique of protesting a water rights application in California, however, has some serious drawbacks. First, by the time most dam builders apply to the Water Resources Control Board for a water right and it comes to hearing they have already decided what the scope and size of their project is and how much firm yield the project is to produce. This thus casts the Department of Fish and Game in the role of spoilers or protestants, and the Department is placed in the position of ascertaining how much they can salvage from the project. This means they are placed in a position of trying to cut into the firm projected yield of the project for instream flows and consequently are in a very heated adversary position since that firm yield represents earning capacity of the project.

Second, a more recent and major drawback to this procedure before the California Water Resources Control Board is that the federal government no longer recognizes the right of the State of California acting through its board to condition a water permit. This is the result of a recent federal decision which we call in California the McBride Decision. The case is entitled "United States v. State of California, ________________." This case was decided on October 9, 1975, and it held that the United States may appropriate unappropriated water in the State of California but must first, as a matter of comity, apply to the California State Water Resources Control Board for a determination by that Board if there is available any unappropriated water. Secondly, when the United States submits applications to the California State Water Resources Control Board that Board must grant such applications if unappropriated waters are available. The reasoning is that since Congress authorized the particular project in question and in that authorization fixed the size of the project and the firm yield, any attempt by the State of California to condition the water right granted to the United States which would in effect reduce the firm yield of the project was void as being in conflict with a congressional act.

In light of the unsatisfactory position the Department of Fish and Game found itself as a protestant in somebody else's water rights hearing, the Department decided recently to file an application to appropriate water for instream use. The problem which has been encountered is the fact that some courts and the Water Resources Control Board itself in California have traditionally required that there be a physical diversion works as a prerequisite to the appropriation of water. In an attempt to overcome this historical prerequisite the Department of Fish and Game has recently filed a test case for the appropriation of water for instream use in the Mattole River on the north coast of California for the preservation of Salmon and Steelhead resources. The Department of Fish and Game in support of that application has made the following legal arguments:

THE POLICY OF THE STATE OF CALIFORNIA CONCERNING PROTECTION OF ITS FISH AND WILDLIFE RESOURCES DICTATES THAT THE BOARD UNDERTAKE TO PASS UPON THE DEPARTMENT OF FISH AND GAME'S APPLICATION TO APPROPRIATE UNAPPROPRIATED WATER IN THE MATTOLE RIVER

It is quite clear that it is California State policy to afford protection to California's fish and wildlife resources. The California Environmental Quality Act requires every State agency and board to carry out this policy. The California Environmental Quality Act of 1970 (§ 21000 et seq. Pub. Resources Code) reads in part:

> ". . . it is the policy of the state to: . . . .
>
> "* * *
>
> "(c) Prevent the elimination of fish or wildlife species due to man's activities, insure that fish and wildlife populations do not drop below self-perpetuating levels, and preserve for future generations representations of all plant and animal communities and examples of the major periods of California history." § 21001 Pub. Resources Code.

See also section 21000(g), Public Resources Code, which states:

> "It is the intent of the Legislature that all agencies of the state government

which regulate activities of private individuals, corporations, and public agencies which are found to affect the quality of the environment, shall regulate such activities so that major consideration is given to preventing environmental damage."

Many other statutes express similar policy of fish and wildlife preservation. See, for example, section 1600 of the Fish and Game Code.

The Department of Fish and Game contended that it was essential for the Water Resources Control Board to recognize and interpret its own statutes in such a manner that will allow the Department of Fish and Game to appropriate water for in-stream use for the recognized beneficial uses of preservation of fish and wildlife resources. The Department believes that the State Water Resources Control Board must do so in order to carry out the State policy with respect to protection of fish and wildlife as expressed in the above code sections.

STATUTORY AUTHORITY CURRENTLY PERMITS APPROPRIATION OF WATER FOR IN-STREAM USES

The Department pointed out that the Board already had authority to allow appropriation of water for in-stream use for beneficial purposes. The Board's guideline is the public interest.

Section 1253 of the Water Code reads as follows:

"1253. The board shall allow the appropriation for beneficial purposes of unappropriated water under such terms and conditions as in its judgment will best develop, conserve, and utilize in the public interest the water sought to be appropriated."

"1255. The board shall reject an application when in its judgment the proposed appropriation would not best conserve the public interest."

In recent years the Legislature has affirmed and emphasized this important function of the Board by including as section 1257 of the Water Code, the following:

"1257. In acting upon applications to appropriate water, the board shall consider the relative benefit to be derived from all beneficial uses of the water concerned including, but not limited to, use for domestic, irrigation, municipal, industrial, preservation and enhancement of fish and wildlife, recreational, mining and power purposes, and any uses specified to be protected in any relevant water quality control plan, and may subject such appropriations to such terms and conditions as in its judgment will best develop, conserve, and utilize in the public interest, the water sought to be appropriated."

The Board's authority to exercise its judgment in the public interest is supported by court decisions. See Johnson Rancho County Water Dist. v. State Water Rights Board, supra, 235 Cal.App.2d 863 (1965), where the court said:

"'Public interest' is the primary statutory standard guiding the Water Rights Board in acting upon applications to appropriate water. (Secs. 1253-1256.)" (P. 874.)

Section 1253 is the cornerstone of the Board's authority. Nothing in this section prohibits the appropriation of water for in-stream use. The only requisites set forth are: (1) the appropriation must be for a beneficial purpose; and (2) there must be unappropriated water available; and (3) the appropriation in the Board's judgment will best develop, conserve and utilize in the public interest the water sought to be appropriated.

The only thing the Department of Fish and Game was asking the Board at this stage was to consider the Department of Fish and Game's contentions that the public interest is best served by conserving some of the water in the Mattole River for preservation of a salmon and steelhead resource. We argued that, if at the threshold the Board refuses to consider this application on the ground there is no physical diversion involved, the Board could not fully exercise its responsibility in the allocation of the State's uncommitted water resources. Nor could it exercise its judgment whether such use of some of the Mattole River's flows would "best develop, conserve, and utilize in the public interest the water sought to be appropriated."

Furthermore, the water policy of the State of California set forth at article XIV, section 3, California Constitution recognizes a right to in-stream uses of water for beneficial purposes. The second sentence of that provision reads in part:

> ". . . The right to water or to the use or flow of water in or from any natural stream or water course in this State is and shall be limited to such water as shall be reasonably required for the beneficial use to be served, . . ." (Emphasis added.)

This language clearly recognizes a right to the flow of water in a natural stream for a beneficial use. That language can only mean that an appropriative right to water may be achieved for in-stream use.

THE DEPARTMENT OF FISH AND GAME CANNOT PROPERLY CARRY OUT ITS MANAGERIAL DUTIES WITHOUT HAVING THE RIGHT TO APPROPRIATE UNAPPROPRIATED WATER FOR THE PROTECTION OF FISH AND WILDLIFE RESOURCES

The California Department of Fish and Game does have the statutory obligation to protect all fish and wildlife resources in the State of California. Of course, fish cannot survive without adequate quantities of water in our rivers, lakes and streams. The Department representing the people's interest should have the right and should be able to stand on equal footing with a farmer raising crops for his own interest, to appropriate sufficient quantities of water in various streams and rivers in order to protect the fish and wildlife resources absolutely dependent upon those waters.

The realities of current practice wherein irrigation districts, the U. S. Bureau of Reclamation, the U. S. Corps of Engineers, and local flood control districts may come in and appropriate water and the Department of Fish and Game is then cast in the role of protestant do not result in adequate protection of California's fishery resources. This is because by the time any federal or state or local agency applies for an appropriative water right, that agency has already determined the scope and size of the project and how much water it needs. The Department of Fish and Game is then cast in the role of ascertaining how much they can salvage from the proposed project. There is no real objective approach permitted in the current system where the Department must be the protestant.

If the Department of Fish and Game can appropriate water - that is, acquire a water right to a given flow for in-stream uses then such water cannot be subject to further appropriation by any other entity including the United States. This would be true even under current federal case decisions.

The Department of Fish and Game and the State Water Resources Control Board can adequately protect fish and wildlife resources dependent upon water in the State of California if (1) the Board recognizes that the requirement of a diversion as prerequisite to the filing of an application is not absolute and should not be applied to those situations where no diversion is necessary in order to put water to a beneficial use, and (2) the Department of Fish and Game embarks upon a program surveying the significant streams throughout the State of California, ascertaining what type of minimum flows are required to preserve the existing fishery resources, and then file an application to appropriate such water to that beneficial use.

THERE IS NO REASON IN LAW OR LOGIC WHY AN APPLICATION TO APPROPRIATE WATER TO A BENEFICIAL USE MUST INCLUDE A PHYSICAL DIVERSION

The Water Code recognizes the use of water for the maintenance of fish life as a beneficial use (§ 1243 Calif. Water Code). It is clear that the Water Resources Control Board would be required to entertain and pass upon an application to appropriate water for fish life if the Department intended to divert water out of a given waterway and run it down a dry wash or into an off-stream reservoir for the purpose of maintaining fish life, because then there would be a physical diversion. It is an absurdity that the Department may not appropriate water for the in-stream use of maintaining a fishery resource because it has no physical diversion. The idea of a physical diversion as a prerequisite to an application for appropriation of water grew up in an era where uses of water were principally for mining and agriculture.

An analysis of case law in California and other jurisdictions discloses that the supposed prerequisite of a physical diversion of water for an appropriation in fact has not been required in any case where such a diversion was not necessary to put water to a beneficial use.

In 1859 the California Supreme Court stated:

> "If, for instance, a man takes up water to irrigate his meadow at certain seasons, the act of appropriation, the means used to carry out the purpose, and the use made of the water, would qualify his right of appropriation to a taking for a specific purpose, and limit the quantity to that purpose, or to so much as necessary for it. So, if A erects a mill on a running stream, this shows an appropriation of the water for the mill; . . ." Ortman et al. v. Dixon et al., 13 Cal. 33, 38 (1859).

In the case of Tartar v. Spring Creek Water and Mining Co., 5 Cal. 395 (1893), the California Supreme

Court protected as a prior appropriation the right of a plaintiff sawmill owner to the flow of a creek:

> "The water of said creek was the motive power by which the machinery of the mill was propelled." (P. 395.)

In McDonald v. Askew, 29 Cal. 200 (1865), at pages 201-06, the court held that a plaintiff flour mill owner had acquired water by appropriation which was a right "to the momentum of its fall at the point where the stream was crossed by the dam, and to the flow of the water in its natural course above or subservient to that end." (P. 206.)

A more recent case arising in California is Hunter v. United States, 388 F.2d 148 (1967). There the court recognized an appropriation of water without a physical diversion, stating at page 153:

> ". . . The outward manifestation is most often evidenced by a diversion of the water from its natural source prior to the use; [Simons v. Inyo Cerro Gorda Mining & Power Co., 48 Cal.App. 524, 192 P. 144 (1920) hearing denied by California Supreme Court, 48 Cal.App. 541, 192 P. 152 (1920)] but it also can be evidenced in other ways, for example, as in this case, by watering livestock directly from the source [Steptoe Livestock Co. v. Gulley, 53 Nev. 163, 295 P.

> 772 (1931)] <u>or as in other cases by placing water wheels into a stream in order to use the flowage as power to operate a mill located on the bank</u>. . . ." (Emphasis added.)

The historical reason requiring a diversion was so that there was a physical indication of the intent to take water presumably necessary to give actual notice to all other persons. Under a statutory appropriation system the reason for the necessity of a physical indication, i.e., to give notice, is supplanted by the notice requirements set forth in the California Water Code.

Other western state jurisdictions have also not required a physical diversion as a prerequisite to an appropriation of water where the water could be put to a beneficial use without such diversion. In Colorado, <u>Empire Water & Power Co.</u> v. <u>Cascade Town Co.</u>, 205 F. 123 (1913), at 129, was such a case. Cascade Creek falls created a mist which provided for luxuriant growth of trees, flowers and shrubs. The court held that a private resort built in the canyon had appropriated the water for maintenance of trees, flowers and shrubs.

<u>Steptoe Live Stock Co.</u> v. <u>Gulley</u>, 295 P. 772 (1931), was a Nevada Supreme Court case in which it was stated as follows:

> "While it was absolutely necessary to divert water from a stream to appropriate it to agricultural uses in an economical

> manner, and the custom of so doing was recognized as an appropriation, it would not seem necessarily to follow that it would be necessary to do so to constitute an appropriation of the water where it could be put to a beneficial use without such diversion." (Emphasis added.)

The court held that a physical diversion was not necessary where the stream was used by plaintiff for watering his cattle.

The Oregon Supreme Court in Masterson v. Pacific Live Stock Co., 24 P.2d 1046 (Oregon 1933), at 1050, dealt with irrigation of lands by means of high water natural overflow of a creek. The court stated at page 1050:

> "It is now well settled that, where practically no artificial works for irrigation are necessary, the requirement of a valid appropriation that there be a diversion from the natural channel is satisfied when the appropriator accepts the gift of nature and indicates his intention to reap the benefits of natural irrigation. . . ."

In Warner Valley Stock Company v. Lynch, Supreme Court of Oregon, 336 P.2d 884 (1959), at 891, the appropriators achieved a vested right in a quantity of water which naturally overflows Hart Lake and irrigated 6,532 acres of grasslands two to three acre feet per acre. This was called a "method of diversion."

See also the Oregon case of In re Water Rights in Silvies River, 237 P. 322 (1925), at page 336:

". . . When no 'ditch, canal, or other structure' is necessary to divert the water from its natural channel, the law does not vainly require such works, prior to an appropriation."

THE LATEST CALIFORNIA COURT EXPRESSION RECOGNIZES THAT CALIFORNIA WATER LAW IS NECESSARILY FLEXIBLE TO KEEP PACE WITH CHANGING SOCIETAL NEEDS

In November, 1975, a decision was rendered in Environmental Defense Fund Inc. v. East Bay Muni. Utility Dist., supra, 52 Cal.App.3d 828, at page 844, the court made this significant statement:

"It seems that the real lesson to be gleaned from our water law history, therefore, is that the courts have generally been acutely aware of the necessity for flexibility in construing the law to keep pace with the needs and transformations constantly taking place in our rapidly changing society.

"The alert trial judge undoubtedly had this in mind when he mentioned in his opinion that he had 'no great difficulty in saying that what is "reasonable" under Article XIV, Section 3, is not fixed and that today a determination of reasonableness should properly include, when appropriate under the facts, environmental factors such as the recreational, fish and wildlife uses of a river. Court decisions applying Article XIV, Section 3, do not preclude such a view . . . .'"

The court also states at page 846:

"Control of the use of all waters of the state for the benefit of the public at large is also spelled out in other provisions of the Water Code itself. For example, under the same heading, 'General State Policy', section 104 provides, 'It is hereby declared that the people of the State have a paramount interest in the use of all the water of the State and that the State shall determine what water of the State, surface and underground, can be converted to public use or controlled for public protection.' A similar expression is found in section 105, which states: 'It is hereby declared that the protection of the public interest in the development of the water resources of the State is of vital concern to the people of the State and that the State shall determine in what way the water of the State, both surface and underground, should be developed for the greatest public benefit.' (Italics added.)"

The Department of Fish and Game represents the people's interest in protecting fish and wildlife. The people should have the same right as a farmer or other diverter to appropriate water to protect their interest.

The Department concluded its argument by stating that the Board in administering State policy on water matters should now recognize the right of the Department of Fish and Game to appropriate water for preservation of fish and wildlife where such appropriation is in the public interest and where it is necessary for the protection of the public interest in the development of the water resources of the State.

ESTABLISHING INSTREAM FLOWS WHERE THERE IS NO UNAPPROPRIATED WATER, PURSUANT TO A STATUTORY WATER RIGHTS ADJUDICATION

The foregoing discussion covers very briefly the efforts of the Department of Fish and Game to achieve instream flows wherein we are dealing with unappropriated water. That leaves the question, "Well, what about the stream where there is no unappropriated water?" In California we have a procedure called statutory adjudication. The purpose of this procedure is to fix the existing rights of water users on a particular given watershed. The Department of Fish and Game feels that if a fishery resource exists in a stream where there is proposed a water rights adjudication, the Department should be allowed to participate on the following theory: Since it is the purpose of a water rights adjudication to fix existing rights of the various claimants to water on a particular watershed based on historical use and since a fishery resource has existed continuously and compatibly with the exercises of the various water rights held by people along the stream, it is the position of the Department of Fish and Game that such a water rights adjudication should be arrived at which will continue the guaranteed existence of the fishery resource.

The Department asserts a property interest on behalf of the People of the State of California in the fisheries within its waters, and it feels that this property interest should have at least equal standing with the property interests of the diverters along the waters which are represented by crops of alfalfa or orchards. We believe that the law of the United States and certainly the law of California is that the title to and property in the fish within the waters of the state are vested in the State of California and held by it in trust for the people of the state. This phraseology was used in the case of People v. Monterey Fish Products Co., 195 Cal. 548, at page 563 (1925). That language was repeated in the case of People v. Glenn-Colusa Irrigation District, 127 Cal.App. 30 (1932), in which the court held that a water diverter could be enjoined from diverting water until such time as he took steps to protect the fishery resource of the Sacramento River by installing a fish screen at the head of his diversion works.

In the case of In re Phoedovius, 177 Cal. 238, at page 242 (1918), the court explained the duty of the Legislature in carrying out its trust responsibilities as follows:

> ". . . the theory being that the ownership of the sovereign authority being in trust for all the people of the state, it is the duty of the legislature to enact such laws as will best preserve the subject of the trust and leave the beneficial use in future to the people of the state."

Very similar language was used by the United States Supreme Court in Geer v. Connecticut, 161 U.S. 519 (1896). Following these cases many California cases have stated that the people of the state own the fish within California waters. People v. Stafford Packing Co., 193 Cal. 719, 727 (1924); Paladini v. Superior Court, 178 Cal. 369 (1918); People v. Truckee Lumber Co., 116 Cal. 397 (1897); Ex Parte Bailey, 155

Cal. 472, 474 (1909). In the case of People v. Monterey Fish Products Co., supra, the California Supreme Court held that the State had a property right in the fishery resources of California and that an unlawful destruction of such fishery resources constitutes an invasion of the State's property right (page 566).

Thus it is clear that the people of the state have a property interest in the fish that exist in given streams and have always had this property interest and that protection of this property interest is at least equal in right to the property interests of the various diverters of water along a stream. It is also clear that the people have never given up this property right. It is the contention of the California Department of Fish and Game that the State in administering the water laws of the State of California through this adjudication proceeding should exercise the trust responsibilities imposed upon the sovereign not only with respect to the dividing of the water but with respect to protecting California's fishery resources.

In the case of Joslin v. Marin Mun. Water Dist., 67 Cal.2d 132, at page 140 (1967), the California Supreme Court stated:

> ". . . what is a reasonable use of water depends on the circumstances of each case, such an inquiry cannot be resolved in vacuo isolated from statewide considerations of transcendent importance. Paramount among these we see the ever increasing need for the conservation of water in this state, an inescapable reality of life quite apart from its express recognition in the 1928 amendment."

This expression bringing in the need to look at statewide considerations of transcendent importance clearly applies to the problem of preserving fishery resources in statutory water rights adjudications. It cannot be refuted that preservation of fishery resources is of statewide importance and that such preservation requires water. If a state water board does not give consideration to protection of fishery resources in adjudication proceedings, it then means that private interests can destroy a fishery resource by dewatering a stream even though that fishery resource belongs to the people of the state. Such a situation cannot be the law. It has been declared that the people have a property interest in such resource and the courts have consistently protected the resources against invasions of that property interest. We cannot see the difference between allowing private interests to destroy a fishery resource under the claim of exercising a water right and allowing a private interest to destroy a fishery resource through excessive harvesting (People v. Monterey Fish Products Co., supra) or by polluting a stream (People v. Truckee Lumber Co., supra).

The foregoing constitutes the current legal views of the California Department of Fish and Game with respect to its right to establish guaranteed instream flows for fish and wildlife uses. No court in California has yet ruled upon these issues, but the issues have been raised. Judicial decision should not be long in coming to determine if the Department is right or wrong.

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THE ROLE OF THE ENVIRONMENTAL LAWYER IN PROTECTING INSTREAM FLOW NEEDS

Scott W. Reed
Attorney at Law
P.O. Box A
Coeur d'Alene, ID 83814

ABSTRACT

In which our hero, like Frank Merriwell, tackles the Corps of Engineers Colonel on the goal line and saves the river to the thunderous applause of bearded backpackers and tennis shod little old ladies; and then our hero spouts radical political heresies including punishing federal liars; enforcment of federal laws; payment for public resources and passage of minimum stream flow laws; after which the grateful government permanently retires the Social Security number of our hero and embosses his briefcase in gold leaf.

INTRODUCTION

The role of an environmental lawyer in the protection of instream flow needs is analagous to playing safety on the defensive football team. While the pleadings may list the environmental attorney as a plaintiff, the game plan is always defensive. We go to court to stop a diversion or a dam or some other water disaster. The opponent is usually the government. We try not to worry about the fact the referee is paid by the other side. The people who hire us-if there are any-are also paying for all the coaches and players on the other side.

By the time we identify the problem, recognize that a lawsuit must be filed and a game played, the other side has finished spring training and all the summer practice games. If it is the Corps of Engineers or the Bureau of Reclamation, they often have been preparing for this particular game for 10 or 20 years. On rare occasions this works to our advantage; some of those game plans are as old as the Statute of Liberty play.

In recent years the competition has been a little better. When Dworshak Dam was being debated, our side had only a couple of biologists and small cheering section of wildlifers opposed by contractors, lumbermen, chamber of commerce free enterprising advocates of government spending and all of the elected politicians in and out of Idaho. The Dworshak game in form of a lawsuit was never scheduled.

Today there is more help. The federal Fish and Wildlife Service and Environmental Protection Agency, state water quality, health and wildlife agencies and private environmental groups have joined the team. We can and do sue. But in terms of available resources, it is still like playing for Boise High against the Dallas Cowboys. The environmental legal advocate cannot expect final victory nor even to score. Like the safety, he can only try to cut off long gains and hope for a fumble or darkness. It is unfortunately still true that a conservation win is only for the day; a loss is forever.

The experience of the Environmental Defense Fund is typical. Brilliant lawyers backed with outstanding scientific testimony provided on donated or cutrate fees won a series of precedent setting preliminary injunctions in suits against the Corps of Engineers under the National Environmental Policy Act.(1) In every one of these cases the Corps thereafter has changed the game plan, modified the impact statement, redesigned the structure, spent more taxpayers' money and ultimately convinced the courts to lift the injunction and let the project proceed.

We live in the decade of the naked emperor. The young men in the media have revealed that our leaders have no clothes and that we have been filled with embarrassed lies. Along with the discovery of some amazing facts about Vietnam, defense spending, and corporate political corruption, the real truth about the management of publicly owned natural resources is finally beginning to emerge from a propaganda overlay as artificial as astroturf and smelling a lot worse.

Within the scope of this conference, the private and public abuses from use and overuse of water are being documented in detail. There are many sources and publications. As a general compilation, both as a Book of Revelations and a general analysis, the National Water Commission Report of 1973 is the water law equivalent of the Pentagon Papers or Nixon's Watergate tapes.(2) Chapter by chapter the NWC Report sets the record straight. The predictable effect of a dam and reservoir is to reduce diversity in organisms and also to create nutrient traps.(3) Channelization has destroyed fish and wildlife habitat and aggravated flooding.(4) The inland waterways program for flat

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(1) Environmental Defense Fund v. Corps of Engineers (Gillham Dam), 470 F.2d 289; Environmental Defense Fund v. Froehlke (Truman Dam), 497 F.2d 1340; Environmental Defense Fund v. TVA (Tellico Dam), 492 F.2d 466.

(2) Water Policies for the Future, National Water Commission, June 1973, U.S. Govt. Printing Office, $8.75.

(3) Ibid. p. 22.

(4) Ibid. p. 34.

water transportation has provided a government subsidized free transportation system without consideration of the effect on other national transportation systems.[5] Government subsidized barges are bankrupting railroads leading to government ownership of the railroads. The taxpayers of the nation have heavily subsidized reclamation projects.[6]

So what has this to do with the environmental lawyer? If you take the narrow view that an environmentalist is only supposed to see to it that the laws are enforced, the NWC Report is irrelevant and inadmissible. In the unfortunate Teton Dam case the Ninth Circuit Court of Appeals upheld U.S. District Judge Taylor's ruling excluding proof that the economics of the Bureau of Reclamation were false and fraudulent.[7] Just as ecology is a broad related science, so I believe environmental law is a broad activity that must encompass not only legal analysis, evidence and trial tactics but also changes in the political structure leading to changes in the law. It is not enough to play defense only if we are going to preserve something worth saving for future generations.

In this time of instant communication in which the news is transmitted and forgotten with equal rapidity, the United States produces a new generation about every four years. The 1968-72 generation was described as "radical". These radicals who were going to shake the pillars of government have long since submerged into selling real estate and used cars or into the government or corporate establishments while the content of that generation's program has evaporated. The term "radical" still retains shock value. With that in mind, I would like to propose a radical four-point legal program for protection of instream values. Since I do not seek martyrdom by being encased in concrete boots in the new American Falls dam, I would prefer that you regard this radical proposal as an in-conference recommendation not for circulation in the Eastern Idaho irrigation districts.

1. It should be a federal offense for a federal official to lie in public or permit his name to be used on printed falsehoods.

A bill to this effect has been introduced in Congress directed to foreign policy deceptions. It ought to be made applicable to all federal water devel-

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(5) Ibid. pp. 115-121.

(6) Ibid. pp. 128-130.

(7) Trout Unlimited v. Morton, 509 F.2d 1276.

opment projects. My theory is for punishment rather like the Securities and Exchange laws. The evil is in deceiving the public. The SEC would never tolerate the circulation of a stock prospectus that was filed with anything approaching the duplicity, deception, blue sky and outright misrepresentation contained in most proposals for construction projects prepared by the Bureau of Reclamation, Corps of Engineers, Soil Conservation Service and Bureau of Indian Affairs. The difference is that all of the taxpayers are being cheated instead of a few gullible fools who buy stock. I don't recommend fine or imprisonment. Instead, conviction should be followed by immediate discharge and termination of retirement benefits. The savings in the national budget from restriction to honest economics with the alternative of termination of retirement pay would be ten times more than any cost for investigation and enforcement.

2. Federal agencies should be required to enforce and obey the laws directly applicable to them.

In my view a major part of the Forest Service public relations problems at the moment is the failure to enforce their own rules and regulations. They have been sued so often they are like insurance companies; they don't know how to be plaintiffs. Litigation, still pending, was brought last summer by a private property owner and a number of environmental groups to stop the Idaho State Highway Department from dredging in the Middle Fork of the Clearwater River which is classified as a Wild and Scenic River.(8) The local ranger and all of the forest supervisors testified adamantly against the proposed dredging. The legal departments of the Forest Service Administration in Missoula and Washington were too frightened or confused to go to court to try to stop an obvious environmental atrocity even though they had spent almost $1 million acquiring scenic easements to protect the wild and scenic river values.

The Bureau of Land Management could administratively act to prevent future land development under the Carey Act and Desert Land Act and thereby protect the Snake River from total depletion. Any reasonable interpretation of the function of the BLM laws would allow for withdrawal of those lands at least until it is known how much water was available. The Bureau is too frightened to go to court on either side.

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(8) Parkening et al v. Idaho State Board of Land Commissioners, Idaho Civil No. 3-75-45.

3. A price should be put on water sought for future withdrawals.

This recommendation was made by the NWC Reports.(9) It has been said that water is the last free resource.(10) Water laws that promoted growth in an unsettled West by giving away public resources are no more relevant to our day and economic conditions than are the mining laws enacted in the year of Custer's last stand. Today in Southern Idaho along the Snake River promoters are filing on public land at $10 and $20 per acre, spending some money to install irrigation systems using free public water and thereby obtain irrigable land selling for $1,000 to $1,500 per acre. A promoter can make a bundle selling the land at those prices to overoptimistic farmers who will go bankrupt trying to raise sufficient crops to pay the loan required to buy the land. The recommendation is not for a per acre foot price but for full repayment of state or federal water resource development projects and for honest economics.

4. Idaho and every other state that does not have such legislation should enact laws to provide for minimum stream flows on all waters in the state.

Later in this conference panelists will discuss minimum stream flow or stream resource maintenance laws in Washington, Oregon, and California. Idaho has no such law. Proposals have been introduced for 20 years. Minimum stream flow is recommended in the Draft State Water Plan. Public opinion polls have reliably shown public opinion in support of minimum stream flow legislation by 80% of the people with only 7% opposed. In the last session of the Idaho legislature, the only reasonable bill died in committee. One ridiculous alternative providing minimum stream flow for North Idaho, which is like providing flood insurance for Death Valley, was defeated on the floor of the House. Probably 80% of the present incumbent senators and representatives oppose minimum stream flow legislation. Since 80% of the people favor it and 80% of their legislators oppose it, the only logical remedy is to replace 80% of the legislators. If you are interested in some nominees for oblivion, the Idaho Conservation League has printed the track records for each incumbent.

People concerned about the future of our streams may not wait. An initiative measure for minimum stream flow was drafted once before and will be again. There is little time to lose. This year the initiative should identify a

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(9) Water Policies, op. cit. pp. 135-142.

(10) "1964: Western Water Institutions in a Contemporary Perspective." Speech by Vincent Ostrom, Resources for the Future, Inc., Western Interstate Water Conference, September 16, 1964.

number of streams and place them in the "instant" category for protection of present instream flow requirements without administrative delay.

In summary the process of protecting the instream flow needs cannot afford the litigation process with its attendant costs, delays and narrow specificity of rivers. The environmental lawyer must take an ecological approach. Litigation is an important, but only a part, of the total ball game.

The classic German military theorist Karl Von Clausewitz once wrote:

> "War is a continuation of policy by other means. It is not merely a political act but a real political instrument."[11]

To an environmentalist, litigation is continuation of political action by other means. What the environmental lawyers need are some radical revisions in the laws so that we can win some of these battles and maybe even win a war.

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[11] War, Politics & Power, Karl Von Clausewitz (1962) Tr. Edward M. Collins.

TOPIC I-C.

FOUR LEGAL VIEWS OF IFN

Summary Discussion

Following Smagge's presentation, discussion continued on the role of the state agency and its basis for establishing the right of instream flows. The "property" of the fisheries as a basis with the necessity for the concomitant flows required for their maintenance was discussed. A question was asked concerning the definition of "self perpetuating" levels of fisheries. Evidently the term was a compromise which apparently requires that all species be permitted to survive. No definite interpretation as yet exists.

Reed's presentation reemphasized his position that a conservative win is "for today," a loss is "forever." His four "radical" ideas were explored. In particular, the establishment of minimum flows was explored. How would these be set--what is meant by "minimum" flow? Reed described the Oregon procedure, and use of the term "stream resource maintenance flows." The situation developing on the Clearwater River, where the Idaho Department of Transportation has been granted a dredging permit (in a section of river designated under the Wild and Scenic River Act) was discussed incredulously. There was disbelief that the Corps of Engineers could really feel that no 404 permit would be required. Reed detailed further his impression concerning the illegality of the issuance of the permit under existing state legislation to the contrary.

Hovis' presentation led to discussion concerning the extent of Indian water claims. Are they interested only in the availability of water for irrigation or might they desire other uses? There appears to be no question that other uses are involved--some stated clearly within the context of the reservation documents. Hovis, however, felt that any use that might be required to establish viable Indian communities would be legitimate claims. The use by Indians for fish and wildlife has also been established in the Caparte and Truckee cases. A question was raised concerning the priority of the Indian water right. It seems clear that the date of priority stems from the date of the reservation establishment. If others had rights before that time, their's would have priority. Concern was expressed that both the Indians and the states were losing by the delays in settling the issues.

Moses' presentation led to a short discussion of the economic competition between electric energy and agriculture. It was made clear that on a simple "ability to pay" basis, the utilities could affort to buy the water. If no water is available, the cost to produce energy may cause significant jumps in power prices.

Notes by panel moderator: John S. Gladwell, Idaho Water Resources Research Institute, Moscow, ID

WATER RESOURCE PLANNING AND INSTREAM FLOW NEEDS--
A RECLAMATION VIEWPOINT

Donald L. Shira
Assistant Regional Planning Officer
Pacific Northwest Region
U.S. Bureau of Reclamation
Boise, ID 83724

ABSTRACT

The Reclamation program, which is nearly 75 years old, has been greatly influenced by changing national priorities. The original intention of the Reclamation program was to provide settlement and economic opportunities through irrigation of public lands in the West. The Environmental Protection Act and the Principles and Standards, plus other acts and policies, have had a major influence on the Bureau of Reclamation's planning program.

The significance of instream flow needs in the Reclamation planning process is illustrated by a discussion of (1) the feasibility study on the potential enlargement of Bumping Lake, Yakima Project, Washington, and the definite plan study on the Touchet Division, Walla Walla Project, Washington, and (2) the Bureau's water management studies in the Yakima valley in Washington, the Upper Snake River Basin in Idaho, and in the Southwest Idaho area. Examples of cooperative efforts with other agencies in determining instream flow requirements, as well as future coordination needs, are cited. The need for improved ISF methodology is stressed. The competition between consumptive and nonconsumptive uses of water is discussed, and the need for legislation to insure instream flows is pointed out.

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When the Reclamation Service was established nearly 75 years ago, its program was intended to provide people with settlement and economic opportunities through irrigation of public lands in the West. The vision of 1902 was to convert arid lands into productive homesteads by Federal construction of water projects, with the costs to be repaid later from the earnings of the settlers. The original objectives of the Reclamation Program were to stimulate settlement of the West, continue agricultural development, and strengthen the regional and national economies.

Several significant projects were authorized during the decade following the Act of 1902. In the Pacific Northwest, these projects included the Boise in Idaho and Oregon, the Minidoka in Idaho, and the Yakima in Washington.

It was just a short time before the objectives of the Reclamation Program began to broaden. The value of water for power generation was recognized in 1906, and legislation was passed permitting the sale of electric power surplus to project needs. The Flood Control Act of 1936 placed strong emphasis on the value of projects for flood control. The Reclamation Project Act of 1939 provided new goals for Reclamation, such as contracting for the sale of municipal and industrial water. This act generally updated and modified previous Reclamation law and clearly recognized the concept of multiple-purpose development.

In the mid-1940's, the multipurpose concept was broadened again to include the preservation and propagation of fish and wildlife. The Fish and Wildlife Coordination Act emphasized the need to place wildlife conservation on an equal footing with other project purposes.

The Reclamation program has been greatly influenced by other landmark legislation affecting natural resource planning and development including the Water Supply Act of 1958; the Federal Water Project Recreation Act, the Water Resources Planning Act, and the Water Quality Act, all coming in 1965; the Wild and Scenic Rivers Act of 1968; the National Environmental Policy Act of 1969; the Federal Water Pollution Control Act; and others.

Administrative and congressional directives have also helped form the Reclamation Program as we now know it. In 1952, the then Bureau of the Budget issued Circular No. A-47 advising water resource development agencies of requirements for evaluations of projects. A decade later, in 1962, Senate Document 97 was issued. This document, which replaced A-47, set new standards for project planning and stressed multiple-uses of water and related land resources.

Within little more than a decade, in 1973, Senate Document 97 was superseded by the Water Resource Council's Principles and Standards for Planning Water and Related Resources. These principles and standards emphasize plans for the use of the Nation's water and land resources should be directed to improvement of the quality of life through contributions to the objectives of national economic development and environmental quality.

To fulfill its multiobjective mission in planning for development of water and related resources, Reclamation has expanded its expertise to include biologists, archeologists, sociologists, and other specialties.

The legislative and administrative tools that demand "multipurpose" and "multiobjective" planning open a myriad of opportunities. There is need for enhancement of fish and wildlife resources, additional recreation opportunities, improved water quality, environmental quality, additional municipal and industrial water supplies, increased hydro power production, and new irrigation development. In some instances, the solution or solutions to several of these needs are compatible. Unfortunately, the available resources don't have the capability to totally meet all needs--competition between uses is evident.

The National Environmental Policy Act and the Principles and Standards encourage a thorough display of alternative uses of water and related resources. These alternatives give the decision makers the opportunity to see the conflicting and competing water uses, and to see the tradeoffs that are involved in the plan selection process.

The subject of instream flow maintenance is a critical issue now demanding the attention of Federal, state, and local legislators and resource planners. Maintenance of instream flows often means that there must be a tradeoff with another important water use--irrigation, municipal and industrial water, or power generation.

To illustrate the significance of instream flow needs in Reclamation planning today, a discussion of some of the projects that are in the planning stage in the Pacific Northwest would be helpful.

Stream maintenance flows are a major feature in a potential project which would involve enlargement of Bumping Lake in the Yakima valley in central Washington. Bumping Lake is an existing storage facility of the Yakima Project.

The Bureau of Reclamation, in cooperation with the U.S. Fish and Wildlife Service, completed a study recently on the feasibility of enlarging Bumping Lake from its present storage capacity of 33,700 acre-feet to 458,000 acre-feet. The enlargement project would be a major step in enhancement of fish resources including steelhead trout; spring and fall chinook; coho salmon, and resident species. Fish enhancement measures includes improved streamflow conditions in the Yakima River System, construction of major new fish hatchery facilities and laddering and screening seven existing diversion dams. Approximately 320,000 acre-feet of the 458,000 acre-feet of storage would be for improved streamflows.

With increased storage in Bumping Lake, downstream flow in Bumping River during August would average about three times greater than those now prevailing (about 805 cfs with the project vs. 240 cfs without the project). Therefore, velocities would be somewhat greater and temperatures somewhat lower at the time when spring chinook salmon enter the stream to spawn.

With enlarged Bumping Lake, flows below Sunnyside Dam would exceed by three or more times the low flows with the existing system. Hence, flows made available from an enlarged Bumping Lake would contribute greatly to restoring and enhancing the salmon and steelhead trout fisheries of the Yakima River System.

Coho salmon would show the greatest increase because of the timing of their migration. They traditionally enter the Yakima in the fall and spawn high up in the watershed in November. Augmented flows in the lower Yakima during the fall would sustain a much larger run of coho as well as a substantial increase in spring chinook salmon.

The Bumping Lake proposal would make a notable contribution toward improved streamflows, but these flows do not meet "optimum" fish flows. In our Yakima Valley Water Management Study, which will be discussed later, we are working with fishery agencies to identify additional opportunities to improve streamflow conditions.

It has been determined through a cooperative effort of National Marine Fishery Service, Fish and Wildlife Service, Washington State and the U.S. Bureau of Reclamation that the Bumping Lake enlargement project could--by improving streamflows and fish passage at existing diversion--restore the natural runs, and with the proposed new hatchery facilities, produce about 9 million fish annually. After project completion, it is estimated that ultimately the commercial catch will be 243,000 fish annually and about 280,000 sport angler days will be realized with a total annual benefit of $8 million (present-day costs). With proper management, it is expected that these numbers could go even higher.

The enlargement project as envisioned now would cost about $100 million. Of this amount, approximately 75 percent of the cost is allocated to anadromous fish enhancement and resident fishery.

Another project of lesser magnitude but equal in importance is our Touchet Project located on the Touchet River near Walla Walla in southeastern Washington.

A major fish resource enhancement feature associated with this authorized project is the improvement of streamflow conditions in the Touchet and lower Walla Walla Rivers during critical fish migration, spawning, and rearing periods. The water to accomplish this objective would be released from the proposed Dayton Reservoir.

In the Touchet River System, coho salmon and winter steelhead are threatened by the present low flows. Water releases from Dayton Dam during the critical migration periods will occur in early fall through winter for returning adult coho salmon and steelhead. The flow at the mouth of the Touchet River is critical at this time to attract the fish. If the flow is insufficient, fish will not enter the Touchet River. Under present conditions, the average monthly flow ranges from 0 to 135 cubic feet per second at the mouth during this critical period. With the project, the flow is expected to be maintained at from 72 to 165 cubic feet per second.

Releases will be made for about a month from mid-April to mid-May for downstream smolt migration. The required fish flow requirements are 100 to 150 cubic feet per second in those reaches.

Stocking of fish and the laddering of existing diversion dams will also be provided. These actions will make it possible to enhance steelhead trout runs and to reestablish coho salmon runs in the Touchet River System.

The increased releases of water during the irrigation period will provide an improved aquatic habitat for resident fish populations and for rearing juvenile anadromous fish. The increased flows with controlled water temperature will improve water quality downstream and provide more available habitat with anticipated increase in aquatic carrying capacity.

An operating agreement will be made with the State of Washington to insure that instantaneous stream maintenance flows provided by the project for fish will remain in the stream for that purpose. The State will continue to enforce statutes and regulations regarding natural flow diversions, monitor streamflows, and inform the Bureau of any failure to comply with the agreed streamflows.

In addition to these two specific projects, I would now like to discuss our Water Management Studies that are underway in the Yakima River Basin in Washington, and in the Upper Snake River and Southwestern portions of Idaho.

These three areas do not have enough water--as it is now used and managed--to meet all the demands, considering both consumptive and instream needs. If we can improve the management of the water supply, many of these needs can be met. This is the long-range goal of our water management studies: To explore better and more efficient ways of using existing storage and other water supplies in order to conserve these resources and develop solutions to other water problems. In other words, we hope to optimize the use of the available water--whether it stays in the stream or is diverted to serve new uses.

Let me list some major study elements; they are all interrelated.

1. We are developing and using computer models of the basin's hydrologic systems as key tools in the water management studies--models of both the surface and groundwater resources.

2. These models then become the basis of systems analyses of the existing river and storage system operations.

3. We will look into better ways of coordinating the use of surface and groundwater.

4. We are looking at alternatives for distributing and managing irrigation water supplies--the biggest consumptive water user in these basins.

5. We are looking at ways to improve hydropower operations at existing powerplants, and we are taking a preliminary look at installing additional generating capacity at existing dams and evaluating potential new hydropower facilities at sites where they will do minimal environmental damage.

6. Finally, the overriding item in water management is determining instream flow needs and finding ways to meet them. The major water conflict in the near future is the conflict between instream and consumptive uses for scarce water supplies.

Virtually all the state or multiagency Federal-state studies made in the central and upper Snake River basins in recent years have stressed the overriding need to determine instream flow needs before consumptive uses preempt available streamflows. The Columbia-North Pacific Region Comprehensive Framework Study, the Western U.S. Water Plan study, the draft of the Idaho State Water Plan, and others all pointed out the critical need for studies of specific instream flow needs. In addition, most of the basin residents responding to various opinion surveys have stated their belief that instream uses should be considered beneficial uses along with municipal, irrigation, and other consumptive uses.

As a result, we are making a real effort to help determine instream flow needs in our Upper Snake River and Southwest Idaho Water Management Studies. The Fish and Wildlife Service has begun cooperative studies of stream resource maintenance flow needs for fish and wildlife. Funded in large part by Reclamation, these studies are being carried out in consultation with the Idaho Fish and Game Department.

Studies are now in progress on about 20 major streams and stream reaches. Many of these are reaches where it may be possible to improve flows through changed operation of existing reservoirs when water is available; these reaches are being given the highest priority.

Reclamation is working cooperatively with the Fish and Wildlife Service during this study so that both agencies become more fully aware of the many factors involved in determining increased flow needs and in providing the flows. Reclamation will evaluate (a) alternative means of providing the desired flows and (b) the impacts on existing water uses if these flows are provided. During dry periods, water supplies are already fully appropriated in some areas.

The Yakima Valley Water Management Study will cover the entire Yakima River Basin in southcentral Washington. Like the Upper Snake and Southwest Idaho studies, we will be looking for measures to improve utilization of water supplies. If water savings can be accomplished and unobligated water supplies can be identified, the full array of unmet water needs will be evaluated to determine the most appropriate use. While the enlargement of Bumping Lake would result in improved streamflow conditions for fish, these would not be optimum flows. Fishery agencies report that additional flow improvement would be required before the fishery could meet its full potential. There is a need to further improve streamflows in the Yakima system for fish.

Instream flow considerations extend to practically every potential development we have under consideration. For example, we are planning to study the justification and acceptability of adding a new hydro generating unit at Anderson Ranch Dam on the South Fork of the Boise River, upstream from Boise. This plant has two generating units at present and space for a third. Addition of the third unit would increase the capacity of the plant by about 50 percent. As a fore-runner to the detailed study, we wanted to take a preliminary look at what might happen to the streamflow situation under simulated operating conditions. In April, we made a week-long series of controlled releases from the dam in order to observe and measure the varying effects that the enlarged plant would have on the river reach downstream. The Fish and Wildlife Service cooperated in this preliminary study step, and the Idaho Fish and Game Department made a special effort to fully participate. The U.S. Geological Survey, Forest Service, and Idaho Department of Water Resources also participated. The significant points are (1) this was the first field work done during this study, not an afterthought, and (2) we believe that the potential impacts on the streamflow of the South Fork will be a major consideration in determining the viability and acceptability of adding a third power unit at Anderson Ranch Dam.

An example of what can be worked out between agencies is the operating agreement at our Palisades Reservoir on the upper Snake River in eastern Idaho where we now maintain constant flows downstream during the goose nesting season. The studies prior to the agreement revealed that flows between 8,000 and 13,000 cfs provided the most nesting habitats (islands) for geese. By keeping the flows in this range, and at a fairly steady release during the nesting season, Canada goose production has risen dramatically. The Idaho Fish and Game Department is pleased with the results of this program, and so are we. We hope the good working relationship which has developed between our agencies will insure the continued success of this program. It may be possible to make the same kind of improvements below other reservoirs.

In conclusion, the problems that I see facing the Bureau of Reclamation on instream flow needs are:

1. Improved methodologies are needed for determining instream flow needs. Two important problems are becoming apparent to many agencies: (1) the lack of workable and agreed-upon methodologies for determining instream flow needs for fish and wildlife and other uses, and (2) the lack of methodologies to measure the values created or preserved by maintaining these flows. Improvements in these areas would improve the planning process, public understanding, decision making, and implementation.

2. Once the better methodology is developed and the streamflow needs are determined, we need to use our imagination to find ways we can meet the realistic ISF needs. Possible ways might be:

a. Better management of existing river and storage systems.

b. Improved irrigation operations.

c. New water supplies for selected problem areas may involve obtaining storage from present water users, obtaining uncontracted storage water through congressional reauthorization of existing projects, or new reservoirs (both on-stream and off-stream) and groundwater.

We are often able to incorporate streamflows in a major multiobjective project plan, but it is often difficult to find a way to implement a solution to a streamflow problem in isolation because of current funding limitations and other constraints.

3. If ways can be found to meet identified ISF needs, there then needs to be commitment from the States in the drafting and application of legislation that will provide a legal basis for utilizing water resources for instream uses. There has been and will continue to be intense competition for water from both consumptive and nonconsumptive users. States need to make commitment if they are serious in treating instream flow needs as an equal partner with consumptive uses. We have in the past and will continue to look to the States for assistance in our planning activities and for providing priorities for water use from their viewpoint.

REASONS FOR PROTECTING WATER RESOURCES FROM DEVELOPMENT

Bruce Bowler, LLB
Ada County Fish & Game League
244 Sonna Bldg., Boise, Idaho 83702
May 4, 1976

ABSTRACT

Water resources have high public interest equities requiring some minimum stream flows. All in-fact beneficial uses need to be considered in management. Environmental Impact Statements are needed on all projects.

Water right laws which permit complete diversion are immoral and equity courts should enjoin complete stream diversion. Failure of State water agency to protect public equities in minimum stream flows is violation of public trust law.

Wild and Scenic rivers are needed to preserve basic quality culture of the nation, and they have high economic values.

Anadromous fisheries are high quality and value resource and hydro-power river management must yield to the better welfare of the fish.

The best reasons for protecting water resources from industrial development are the high public interest equities in having at least some minimum stream flows in our natural water courses. Reasonable and fair use of our water and water courses require proper evaluation of all of the beneficial uses that in fact exist. This should be the primary function of Environmental Impact Statements which should be employed on all projects involving water use. While it is unfortunate that most of this is too late to protect the public equities, that is not valid precident for not doing it henceforth, and also requires genuine effort to rehabilitate where feasable our water ways from the standpoint of ecological quality.

Water rights under law which permit the complete diversion of public waters of a stream for private use to the full loss of the public equities in beneficial uses of the stream are socially immoral. Equity courts should enjoin the complete appropriation for diversion of a stream. This rule needs of course to contemplate application of degree, however any state administrative agency of the public waters of a state should protect minimum stream flows needed by the biology of a river for the beneficial uses of fish and wildlife and recreational values of the water. Failure to do this is a violation of the public trust under which a governmental agency is supposed to administer the public resource for the benefit of the true public interest.

The public interest values of the public waters of a state contain many reasons for protecting them from development noteables being those that have to do with a quality of life related to recreational uses of fishing, hunting, swimming, boating, floating, canoeing, kayaking, camping, sight seeing, photography, archeology, biology, and aesthetic ecological quality. A most important myth that needs discrediting is that principal beneficial uses of our streams are related to traditional development for agriculture, hydroelectric power, navigation, and industry. Nothing could be further from the truth as applied to the few residual undeveloped streams. This old myth about paramount public interest resulting from industrial development should now be put down.

This doctrine is well illustrated by the monumental decision of the United States Supreme Court in Udall vs. Federal Power Commission, 1967, 87 Supreme Court Reports 1712 which paved the way for denial of industrial development of the remaining bit of undeveloped Hells Canyon.

We need wild and scenic rivers because the few we yet have opportunity to preserve represent a basic part of our quality culture that this generation has no right to foreclose. To preempt the options for future generations would be extremely selfish. Some people seem to consider this to be the last generation to occupy the earth. But we need now to be very careful with the unspoiled rivers. Another common myth which should also now be dispelled is that wild and scenic rivers do not have high economic values. Ask any one who uses them and they will dispute that myth. But more directly let us apply ordinary legal rules of compensation for damages for something good taken away from another, such as comfortable health spoiled by personal injury or loss of a member of the family by wrongful death, even by todays standards of damage values the loss to the people of your state and the nation for destruction of our residual wild and scenic rivers projected over even <u>one or more</u> generations could only be expressed in many billions of dollars. These kind of values should always be cranked into the economic sections of Environmental Impact Statements even over the objections of advocates for industry who claim such are too speculative.

To optimize streamflows for environmental enhancement or preservation while permitting beneficial uses require administrative studies to formulate and implement water plans for optimum development of water resources in the public interest. Here again another popular myth needs to be dispelled, that being that the law presumes the word development means only agricultural or industrial development. This of course is not true where the law requires that the development be in the public interest, because often the fact is that private agricultural and industrial development is not in the public interest. The proper construction of this law is that the administrative agency has the duty to first determine what is in fact in the public interest and implement the water plan for optimum development of water resources in that public interest. In many cases the public interest in streamflows for environmental enhancement or preservation of fish and wildlife uses are development that will far outweigh diversion for private agriculture. The monkey is on the back of the administrative agency to do what in fact is in the public interest not only by the express terms of the law, but also in furtherance of its fiduciary duty to perform the equitable trust for the beneficiary of that trust, i.e. the people that own the resource constitute the public interest.

There of course can be issues of fact over what is in the public interest, and the public should have something to say about what is in their interest through the EIS process.

We can most effectively preserve our anadromous fishery resources by water quality control on anadromous streams. This includes flow regimens through dams for temperature and nitrogen super saturation control with priority regard for the fisheries in the stream flow management. The fish need to be given equal consideration with kilowatt production, and there are times when higher public interest rests with fish protection than hydro power. The agencies having responsibility for fish safe stream management are those who control the flows with the advice and cooperation of the fish and wildlife agencies both federal and state. Failure to operate in such pattern is abrogation of the public trust under their control over the water based resources for which they should be liable to owners and beneficiaries of the trust properties including public fish and wildlife. Another fallacious myth is that the fish are dispensable in deference to the power. Competent environmental litigation could change this under the common law of equitable trust administration as the legal basis for actions.

Water use in our anadromous streams usually involve significant federal action affecting the quality of human environment requiring the use of EIS in the planning and decision making respecting the public resources under use.

The information needed to classify a stream as a wild and scenic river relates to the Wild and Scenic Rivers Act, 1968 Public Law 90-542 which provides that it is United States policy that rivers which possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values, shall be preserved in free-flowing condition and that they and their immediate environments shall be protected for enjoyment of present and future generations. Options are provided for the States to establish wild and scenic rivers within the federal criteria with state administration. In either case wild or scenic river classification involves significant governmental activity requiring the EIS process which will of course result in the maintenance of instream flows of the water. The National Environmental Policy Act 1969 42-US Code-4321 requires the EIS to submit alternatives for public comment on the issues, and the variety of environmental impacts that are called for are too extensive to be treated in this kind of paper, but like sex these will come natural to those working on environmental problems who care.

Problems encountered in preservation of established natural areas during low streamflow periods deserve to have augmented stream flows from other priority water rights and the best example I can think of is that salmon should not be caused to die from lack of water in the Lemhi River in Idaho diverted to irrigate alfalfa. Some minimum flow should be required by the laws of equity sufficient to sustain public interest fisheries. Problems yes, but impossible of solution no.

RECYCLING A RIVER: DENVER'S PLATTE RIVER GREENWAY PROJECT

Robert M. Searns
Denver Planning Office
Platte River Development Committee *
Denver, Colorado 80202

ABSTRACT

Modern technology while providing a better material existence, has taken a heavy toll on the urban habitat. River restoration suggests a way to reverse the process of environmental degradation and re-integrate nature into the urban fabric. A restored urban river can provide a focal point for inner city revitalization, a feature around which quality commercial and residential development can materialize. Denver's Platte River Greenway Project attempts such re-integration, an experimental "de-mechanized zone" in the heart of the city. The Greenway project aims to restore the entire 10 mile (16.9 km) reach of the Platte through Denver, a first step in creating a region-wide open space corridor extending from the Platte's source waters, in the mountains nearby, downstream to the northern limits of the metropolitan area. Two of the four original demonstration projects are completed and in use. A third is well underway. Fast implementation, cost efficient design and construction, full utilization, and quality maintenance were considered essential if the project was to be a success; a model for others to follow. The "fast track" approach has been used. If it is to be effective and cost efficient "fast tracking" necessitates the ability to make sound on-the-spot-decisions. Reliable and comprehensive information in a number of areas has been integral to that decision-making process. An objective of the Greenway project has been to find ways to live with conflicting uses and where possible to turn them into assets. Our society has myriad needs and interests all competing in the political and economic arena. While not an easy task, a place must be found within this arena for environmental restoration. The Platte River Greenway Project is an attempt to help lay the groundwork for restoration.

INTRODUCTION

Modern technology, while providing a better material existence, has taken a heavy toll on the urban habitat. Asphalt and concrete has replaced sod and trees. Rivers and streams are fouled. Wires, buildings and billboards clutter the horizon. The delicate pleasures and mysteries of nature have given way to the noise and fumes of mechanization.

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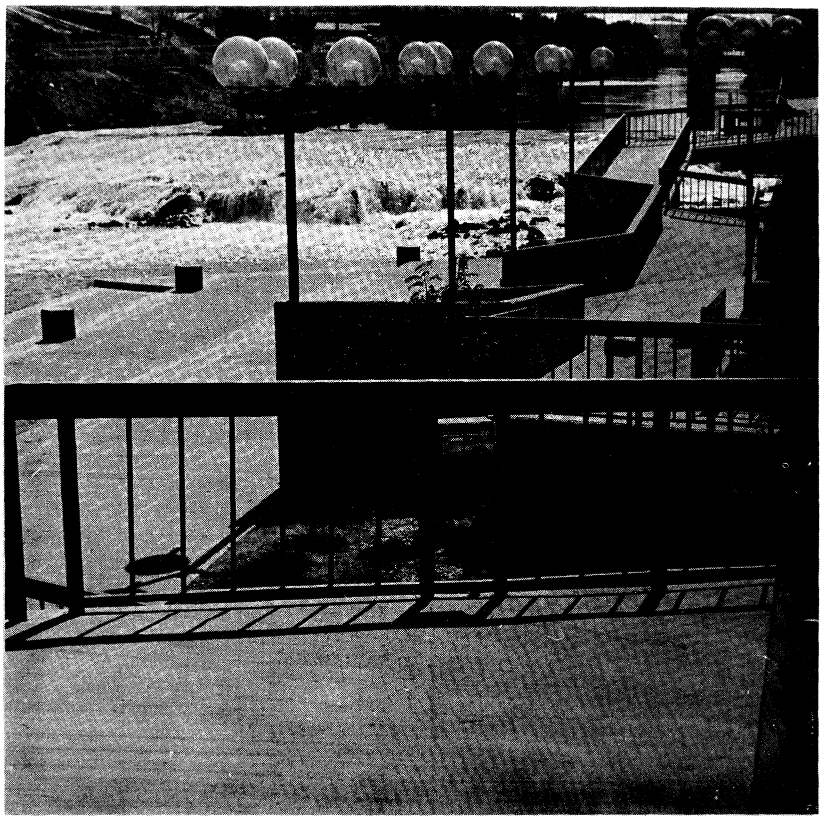
* Special thanks and acknowledgment to my co-workers on the Greenway Project: Rick Lamoreaux, Wendell Keller, Lew Calveresi, Courtney Taylor, and to Alan Canter, Director of the Denver Planning Office, for his active support of the project.



River restoration suggests a way to reverse the process of environmental degradation and re-integrate nature back into the urban fabric.

The Benefits of Restoration

River restoration suggests a way to reverse the process of environmental degradation and re-integrate nature into the urban fabric. A restored urban river corridor, readily accessible to city dwellers, offers numerous benefits It can serve as a place of refuge and a close-in, quiet retreat from the surrounding city's intensity. An alternative to remote rural retreats and wilderness areas, access would not require large quantities of gasoline. It can be a unique place to play and to learn. In conjunction with a system of river-bank hike/bike trails, the river corridor can offer an alternative space in which to move about and experience the city away from the hazards and unpleasantness of automobile traffic.

A restored urban river can provide a focal point for inner-city revitalization, a feature around which quality commercial and residential development can materialize.

The restored river corridor benefits nature. By attracting people to the river bank, a first hand awareness of man's relationship to natural processes can be instilled. Industrial and municipal polluters along the river become readily visible and, therefore, subject to direct public pressure to end such abuses. The river, with its cleaned-up waters and restored banks, can also become a recycled habitat for many species of plant and animal life which have been driven from the urban setting.

The Greenway Project: An Experiment in Restoration

Denver's Platte River Greenway Project attempts such re-integration, an experimental "de-mechanized zone" in the heart of the city. The Platte is itself a microcosm of the man-nature conflict. Once the life force of a beautiful valley, the river now flows through one of the most badly degraded and blighted sections of the city.

The potential, however, is there. The river continues to support an array of plant and animal life along its banks. The movement of its waters still calms the ear and refreshes the spirit. Descending into the river flood-way itself, one leaves the city bustle and re-discovers the sights, sounds and smells of nature. For Denver, this was the place to start the restoration process.

The Goals and the Process

The Greenway project aims to restore the entire 10 mile (16.9 km) reach of the Platte through Denver--a first step in creating a region-wide open space corridor extending some 50 miles from the Platte's head waters, in the mountains nearby, downstream to the northern limits of the metropolitan area.

A three-step implementation process was planned with the project's inception in June of 1974. The first step, scheduled for completion in September of 1977, is the installation of an eight-foot-wide (2.4 meter), concrete hike/bike trail running the river's length through the city. In conjunction with trail development, there is extensive visual treatment, including bank re-grading, clean-up and landscaping. Feature areas, including boating facilities, picnic spots, and amphitheaters, are strategically placed along the trail corridor.

Spanning a three-to five-year period, the second step anticipates creation of a large, regional park in the river flood plain adjacent to the downtown area. New, river-oriented commercial and residential development overlooking the river is also planned.

The third step, extending over a 10 to 15 year period, includes continued expansion and embellishment of the Greenway corridor. A competition, whitewater Kayak course is planned along with theme parks, special projects by citizens groups, and educational exhibits.

The work was initiated with the design of four discontiguous, one-mile (1.6 km) "demonstration" projects. These projects, spaced at approximately one-mile intervals, were intended to change the public's impression of the river as a degraded area and show its potential as a unique recreational facility. Each project includes a segment of trail and feature facility aimed at attracting users to the new recreational resource. Following completion of the four demonstration projects, work was to begin on four connecting projects to link the continuous, ten-mile corridor.

Progress to Date

Two of the four original projects are completed and in use. A third is well underway. Due to a delay in receipt of federal funds, the fourth project has been deferred. However, three connecting segments have been funded which will link the demonstration areas and complete seven of the ten miles. Additional funding has been sought to complete the remaining three miles.

Strategy for Successful Implementation: Some Key Considerations

As an out-of-the-ordinary kind of public works endeavor, the Greenway project has faced skepticism, if not outright resistance, in some quarters. All too often, projects of this nature are considered visionary, "pie in the sky"--

a "nice idea," but not very practical. Slickly presented and zealously promoted, plans for such projects usually end up gathering dust on stockroom shelves. To avoid this fate, the Greenway idea had to quickly be given "substance" in the minds of public officials and the citizenry at large. Fast implementation, cost-efficient design and construction, full utilization of the improvements, and quality maintenance were considered essential if the project was to be a success--a model for others to follow.

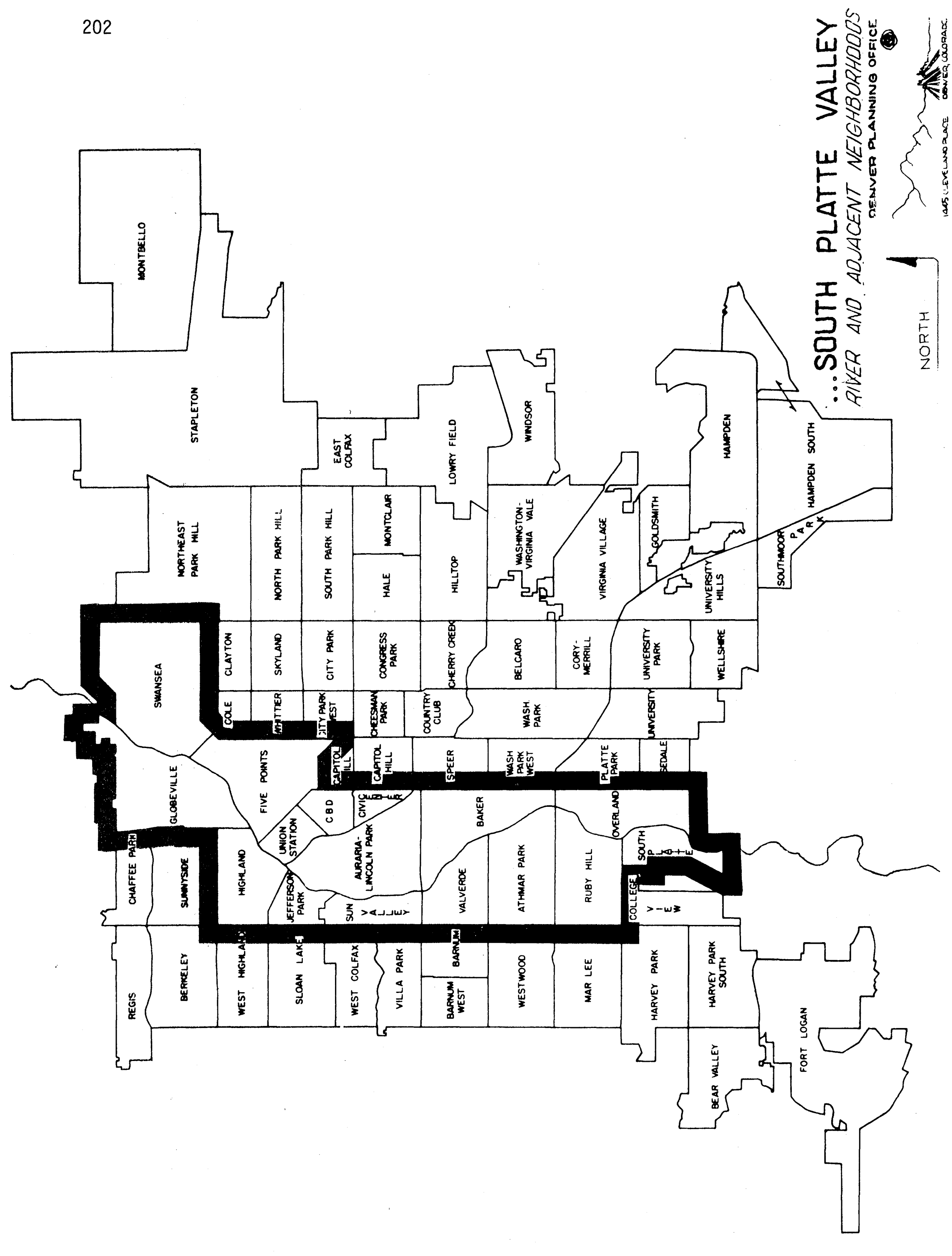
The Greenway project needed aggressive, action-oriented leadership. Flexibility, openness to new ideas, a willingness to take risks, coupled with a sense of pragmatic responsibility were the qualities called for. To meet this need, the Platte River Development Committee was established. The committee, a high-powered, 9-member task force consists of representatives of the community known for their accomplishments in various areas of civic interest. Their chairman, Joe Shoemaker an influential Colorado State Senator, has had a long-standing personal interest in, and dedication to, restoring the Platte.

In contrast to existing city agencies which have a range of prior responsibilities and commitments, the committee is an independent entity with a single charge: the successful execution of the Greenway project. Cooperation and coordination with city agencies, however, has been essential.

It was important that the project build momentum quickly, that a "beachhead" be established in the form of constructed improvements. To accomplish this, the committee has pursued a "fast-track" approach, wherein elements of the planning, design, and construction phases overlap. The committee quickly agreed on an overall concept, retained designers, and bid the first segment of the work within four months of its inception.

The "fast-track" approach made possible by an initial allocation of project "seed" money: a $3 million appropriation by the Denver City Council. Not only has this seed money demonstrated the council's commitment to the project, but it has helped legitimize the project in the eyes of prospective outside funders, including federal, state and private sources.

The initial "seed" money, however, was just enough to get the work started. Application for additional funding was made to a number of federal and state agencies. Pending receipt of this additional outside funding, the objective has been to get the greatest impact for each dollar in hand, yet also to maintain a cash reserve in order to match anticipated grants. This implies the need for nimble, budgetary decision-making. To aid in this process, the committee's staff closely monitors expenditures and regularly develops alternative funding strategies which are tested against a range of likely future situations.



...SOUTH PLATTE VALLEY
RIVER AND ADJACENT NEIGHBORHOODS
DENVER PLANNING OFFICE
1445 CLEVELAND PLACE DENVER, COLORADO
NORTH
MONTBELLO
STAPLETON
EAST COLFAX
LOWRY FIELD
WINDSOR
HAMPDEN
HAMPDEN SOUTH
NORTHEAST PARK HILL
NORTH PARK HILL
SOUTH PARK HILL
MONTCLAIR
HALE
HILLTOP
WASHINGTON-VIRGINIA VALE
VIRGINIA VILLAGE
GOLDSMITH
UNIVERSITY HILLS
SOUTHMOOR PARK
SWANSEA
CLAYTON
SKYLAND
CITY PARK
CONGRESS PARK
CHERRY CREEK
BELCARO
CORY-MERRILL
UNIVERSITY PARK
WELLSHIRE
COLE
WHITTIER
CITY PARK WEST
CHEESMAN PARK
COUNTRY CLUB
WASH PARK
UNIVERSITY
GLOBEVILLE
FIVE POINTS
CAPITOL HILL
SPEER
WASH PARK WEST
PLATTE PARK
ROSEDALE
UNION STATION
CBD
CIVIC CENTER
BAKER
OVERLAND
CHAFFEE PARK
SUNNYSIDE
HIGHLAND
AURARIA-LINCOLN PARK
VALVERDE
ATHMAR PARK
RUBY HILL
SOUTH PLATTE
JEFFERSON PARK
SUN VALLEY
COLLEGE VIEW
REGIS
BERKELEY
WEST HIGHLAND
SLOAN LAKE
WEST COLFAX
VILLA PARK
BARNUM
BARNUM WEST
WESTWOOD
MAR LEE
HARVEY PARK
HARVEY PARK SOUTH
BEAR VALLEY
FORT LOGAN

The primary emphasis has been placed on funding trail construction. The trail will get people down to the river. A private foundation has been established to fund additional improvements through individual and corporate donors. A local bank for example, runs an annual promotion in which each new savings account results in a contribution by the bank to the foundation. Thus far, enough money has been raised privately to adequately support the landscaping of completed trail segments.

Along with adequate financing, a strong base of public support is necessary to assure that momentum continues and the project is completed. Promotion has included brochures, an audio-visual presentation, close work with citizens groups, and regular exposure through the press, radio and T.V. stations. Special events such as ground breakings, opening celebrations, and river-cleanup campaigns have helped to reinforce public interest.

To broaden local neighborhood involvement, the four initial demonstration projects were spaced at one-mile intervals along the river's ten-mile reach has helped to assure a continuing interest in the project pending completion of the entire ten-mile corridor.

Direct public involvement is paying off in many unexpected ways. Volunteers have come forward to assist in planting and river cleanup. Valuable skills in such areas as white-water boating, graphics, and landscaping have been made available at no cost by interested citizens. Feedback at public presentations has resulted in many new ideas which have been incorporated into project designs.

Kinds of Information Needed

The "fast-track" approach, if it is to be effective and cost efficient, necessitates the ability to make sound, on-the-spot-decisions. Reliable and comprehensive information in a number of areas has been integral to that decision-making process.

A regularly updated listing of current material and labor costs for various components in the construction process has been kept on hand, making it easier to assess the cost implications of various design alternatives.

Hydrological information about the Platte, a basically unpredictable river, has been incorporated into the design process, assuring that improvements do not exacerbate flood problems nor fall prone to flood damage themselves.

Land ownership in the river corridor has been carefully logged, and plotted on working drawings. The committee, with its limited funds and delicate political posture, is not in a position to condemn property --negotiated purchase and license agreements have been relied on. For this reason, it has been important to resolve land-ownership issues early in the design stages if costly re-designs or modifications are to be avoided later.

User market data is needed to determine the appropriate scale and kinds of facilities to be developed as well as to justify federal state funding applications. Because of the subjective nature of recreational values, such data is difficult to produce in numerical form. References published by the Federal Bureau of Outdoor Recreation and the Department of Transportation have been helpful in providing a cross-section of recreational and bikeway needs in cities comparable to Denver. Consultation with local, parks-administrative personnel has also provided valuable insight into user needs and maintenance costs.

User Safety and Security

While outdoor recreational activities always involve some risks and hazards to users, there is a moral, as well as legal obligation to plan, design and build improvements in a manner which minimizes those hazards.

To promote defensive design, specific safety standards have been adopted with respect to the hike/bike trail, boating facilities and feature areas. These standards address the full range of users, including the elderly and the handicapped. To promote personal security and reduce vandalism, a bicycle-mounted, Greenway security patrol consisting of trained interpretive guides in radio contact with city police has been proposed.

Problems as Opportunities: The Multiple Use Concept

Historically, river corridors have been the focal point of urbanization. In Denver, too, the river was, and is, a vital element in the city's development. Many pre-existing uses compete with the concept of a recreational and aesthetic amenity along the river. Industrial activities, transportation and utility corridors, water impoundments and flood control devices all occupy the Platte's right-of-way. While these uses are seemingly incompatible with restoration, their relocation would be extremely disruptive and costly. Accordingly, an objective of the Greenway project has been to find ways of living with conflicting uses and, where possible, turning them into assets.

To this end, the committee has worked closely with private and public concerns to promote compatibility. A public utility company has screened its transformer substation located on the river bank with an attractive, landscaped wall. A stockyard has become a point of interest for trail users. A dam used to impound cooling water for an industrial operation is to be modified to serve as a gate structure for a man-made kayak course. The impounded water behind that dam will be utilized as a boating pond for less experienced boaters unable to navigate the Platte's often turbulent waters. A flood control culvert has been re-designed, using architectural facades, natural stone and wood, to create a boat lagoon and picnic area. Interpretive graphics, murals and landscaping are being used to soften and enhance the visual impact of industrial operations along the river.

Finally, the Greenway concept itself is not intended to pre-empt or replace existing urban land uses. Rather, it is intended to complement the urban setting by providing a seed around which quality, inner-city redevelopment can crystalize as an alternative to costly and ugly urban sprawl.

Conclusion

Our society has myriad needs and interests, all competing in the political and economic arena. While not an easy task, a place must be found within this arena for environmental restoration. The Platte River Greenway Project is an attempt to help lay the groundwork for restoration.

In the political milieu, substantial footwork is required. Local decision-makers must be convinced of the validity of the project. A solid public constituency is vital. This requires project leadership which is sophisticated as well as influential in the local political process. This leadership must be committed, but willing to compromise--responsible, yet willing to take risks.

Adequate financial backing is essential, but not without recognition of other local priorities. In Denver's case, the city was able to put up the "seed" money. It could be demonstrated to City Council that the project would pay off. A new recreational facility would result; and, by stimulating inner city re-development, the city would enjoy an improving tax base.

Beyond initial seed money, additional funding must be found. State and Federal grants provide a source, but such funding is limited and dependent upon current fiscal and political circumstances. As an alternative, the author suggests a special fund earmarked for restoration projects and funded by taxes on new development or environmentally abusive activities. In Colorado, a Conservation Trust Fund has been set up by the State Legislature for this purpose. This approach, if applied at the national level, could provide a substantial funding pool for restoration projects.

Planning for restoration must be strongly implementation-oriented. It has been the philosophy of the Platte River Development Committee that planning is meaningful only when it results in change. The actual installation of in-the-ground physical improvements was needed to start the process--to generate the momentum needed to see through a more comprehensive plan for inner-city redevelopment.

The Platte River Greenway Project set out to make a point: that there is room for both progress and preservation, for the romantic and the pragmatic. These values need not be mutually exclusive. They can be complementary if there is a holistic awareness and a willingness to work toward a balance of values on the part of those who shape our environment--the policy makers, the designers, and the engineers.

INSTREAM FLOW NEEDS AND THE EIS:
A MATTER OF VALUES

Robert C. Erickson
Environmental Consultant
Longmont, CO 80501

INTRODUCTION

My talk today is going to deal with cakes and water and fish and recreation, uniqueness and EIS's, and most of all, values. I present no data, but suggest a way of looking at assessments and the goals of assessments.

My thesis is that, at the core, the importance of an EIS is its assessment of losses or gains of values. I believe most EIS's have not done well on this score; and I believe that statements that do not clearly present losses and gains in terms of values allow poor decisions to be made on the use of our water resources.

Parameters, Values, and Significance

At the outset I need to differentiate clearly between two terms. They are basic to what follows and have been used in other ways. These terms are parameters and values, both of which can be affected by streamflow manipulation.

By parameters, I mean physical, chemical and biological changes of the stream ecosystem that are not dependent upon human reactions or emotions. Examples are: velocity, depth of pools and riffles, stream bottom wetted area, benthic food production, fish spawning area, habitat and food for wildlife, and similar types of items.

By values I mean attributes of stream ecosystems that people emotionally relate to. Examples are: fishing enjoyment, food, canoeing, aesthetic pleasure, hunting, wildlife observing, a drinking supply, water that allows industry and agriculture to supply jobs, and flood control. Under values, I also group management objectives that are related to more basic values and might be considered sub-values to particular segments of our population. Some examples under the general heading of fishing values might be: management of a stream for trophy trout, for maximum number of fish in the creel, for a particular fish species, for children's fishing, or for summer fishing only.

As I was writing I found a useful analogy between decisions used in making or buying a cake and those of evaluating the effects of stream flow manipulation. If you were a baker considering the effect of altering porportions of ingredients in a cake you might consider changes in the amounts of flour, salt, sugar, baking powder etc. These modifications would lead to effects on such parameter as the consistency of the cake, its lightness, its color, and so on. These effects on parameters would, in turn, attach importance as you considered the values (the whole purpose) for which the cake was made: i.e. food value, visual attractiveness, tastiness, etc. You would alter your ingredients to reflect the importance of the one or several values you wished to achieve.

Similarly, if you consider changes in the "recipe" for streamflow -- increases or decreases in any of the 365 days of the year or 24 hours of the day -- you are led to thoughts of changes in wetted area of the stream bottom, depth of pools and riffles, production of insect and other benthic life, spawning area for fish, and associated changes in temperature, dissolved oxygen, and other physical and chemical parameters. Very often these parameters, rather than the values that are lost or gained, are the kinds of changes considered by environmental impact statements, and the kinds of changes many professionals and agencies find themselves concerned with.

We who write or review EIS's -- seeking to come to a true appreciation of what the effect of a proposed action may be -- often spend the bulk of our time on assessments of parameters, the flour and sugar and salt of the cake. I believe these aspects are important, but are really secondary to the decision-making process.

The whole purpose of an EIS is to enable an intelligent appreciation of "So what"? There is a project or there is a policy -- So what? There is a description of the geology, and hydrology, and biology and all the other "ologies"-- So what? There is a listing of losses and gains of existing or potential resources ranging from rocks to fish, water to trees, minerals to mammals -- So what?

How many of you administrators and resource porfessionals, not to mention the public, have gotten bogged down in an EIS in a profusion of data and discussion which often nowhere succinctly address the "So what" -- What <u>values</u> exist potentially or actually and what <u>values</u> are being gained or lost as the result of the action or policy.

Most people are not basically concerned with the wetted area of a streambed, the amount of spawning area available for fish, the height and velocity of the stream or any of the physical, chemical, or even biological attributes -- we are concerned only so far as we see these factors affect our values. How is my fishing enjoyment affected? How is my canoeing affected? If the reduction in stream wetted area does not affect my fishing noticeably, then I am really not too interested because I perceive my value has not been threatened. If dissolved oxygen is reduced because of low stream regimes, it is only important to the angler as it affects his fishing recreation or to the person who enjoys seeing a clear stream, free of slime growth or foul smell. Fishing recreation and enjoyment, aesthetic pleasure of seeing a waterfall rather than a culvert pipe or a trickle, sufficient water to canoe on, food as fish protein produced -- these are assessments that people (and agencies responsible to people) can relate directly to -- can place in their value system and say, "This is a meaningful loss, and this is a meaningful gain, and this is a ranking of the losses and gains in order of priority to me." Parameter information, valuable as it is, and interesting as it is to many of us professionally, is only a predecessor to estimating affects on values.

It is this loss or gain of values that people perceive as important and which is often looked for in vain in an environmental impact statement.

My first point, then, is if you are involved in environmental impact statements involving water resource use either as a writer or as an agency reviewer or as a concerned citizen, insist that your thinking and the documents submitted to you be attuned toward assessment of what values are lost, gained, diminished, or enhanced.

Values are human and political attributes. Water use and instream flow needs are essentially politcal decisions with scientific input. And I use the term "political" in what I consider its good sense, the choosing among values by people, all the people and with all of the values known. When the values to be gained or lost are known we can make good choices. When the values are confused and must be extrapolated from data or parameters, poor decisions as to the use of a resource are encouraged.

Decision Criteria

A very real problem is still, how do you go about making justifiable decisions on water use based on loss or gain of values? It is a difficult question and I do not have a complete and best answer. My experience in writing and reviewing EIS's over the past 5 years, however, has led me to suggest two criteria be strongly considered as predominant additions to the usual criteria as a decision basis for evaluating and deciding among competing values. These criteria are diversity and uniqueness.

Within any political or geographical area, the concept of diversity, as I use it, recognizes the desirability of maintaining many kinds of human values and environmental resources. The concept of uniqueness, as I use it, recognizes the relatively greater worth of resources and values that are uncommon within any particular area. Both concepts are related and yet have separate and useful meanings. It is partially from a personal bias that I emphasize these concepts, for I believe that for the enhancement of human enjoyment, (and perhaps as an influence on the survival of the people of our country), our policy should be to encourage the preservation of a diversity of natural and human habitats and human value experience and to provide opportunity for these values to be enjoyed in more than just a few places. I believe that at present we cannot accurately predict what human and natural attributes will be of most value 25 or 50 years hence.

As an example of the use of the criteria of diversity and uniqueness in an environmental impact assessment of water use let us consider an action that would divert the major portion of the summer flow of a stream for irrigation. Potential or actual values in the stream we will consider as canoeing, trout fishing for children, and aesthetic beauty of waterfalls. The conflicting values in this case are economic value to one or several farmers, and food values to people that might be foregone if irrigation flow is not allowed.

On the basis of diversity we would consider whether all of these values existed in our area of concern -- say, within an hour's drive of a metro area like Denver. If the diversion of a major portion of the summer stream flow would largely eliminate any of the identified existing values of canoeing, children's trout fishing, and aesthetic beauty of falls in the area; or if not taking a major portion of the summer stream flow would largely eliminate food values produced in the area or not allow farmers to economically exist in the area, then there would be a loss of diversity. If none of the existing values would be lost, and some additional values gained: then diversity would increase.

A major consideration in decision-making and consideration of alternative sites or uses should be to prevent the loss of diversity of values available to people of the area, and if possible to increase the diversity.

For the present, considering all values of intrinsically equal rank, the more values lost, the greater the impact, This measure of loss would be in addition to the number of people that might be presently affected by the loss of, say canoeing values. By attaching separate importance to the loss of diversity the assessment tends to account for the lost availability of this resource value to future generations and to people not yet ready to enjoy canoeing, and it makes the net loss of greater significance.

Very often, however, changes in streamflow are not so clear-cut as to largely eliminate a value from a political or geographical area. Often, the result is a change in the relative balance or availability of values. In this case, although there is no loss of diversity in the area, the criteria of uniqueness provides us with some ranking or decision-making ability, since uniqueness refers not only to whether or not a resource or value is present, but to its relative abundance. In our example let us assume that a resource agency has determined that a portion of the stream to be affected is ideal for children's trout fishing on the basis that it is desirable for people to be able to fish as youngsters, the stream is easily accessible to children, and the stream is capable of supporting fish. The existing flow regime supports this value in addition to canoeing and aesthetic values. Additionally, we assume that there are some, but few, other streams in the area we are considering that can provide these values.

Under these conditions diversity (as we are using it) is not diminished, but there is a finite loss of the availability of unique values to people of the area.

If all values are considered intrinsically equal, this loss of uniqueness can be quantified by considering its significance roughly proportional to the percent loss of numbers of falls, miles of children's trout fishing water, or miles of canoeing water that will be lost by the action.

For example, if there were only six miles of children's trout fishing stream in the study area and two miles of this were lost by stream diversion, then there would be a unique value diminished in availability by 33%. Similarly there may be 10 miles of canoeing and 10 waterfalls on the stream affected by flow diversion, compared to a total of 50 miles of canoeing and 20 beautiful waterfalls in the study area. The availability of a unique value diminished by a flow loss is therefore 20% and 50% in these cases. Ratings of losses in this manner tends to emphasize the importance of each additional loss of availability as the amount of the resource value becomes smaller.

In considering the conflicting values, farming may be a large industry in the area of concern and therefore not qualify as relatively uncommon or unique value. The loss of food production by denying or reducing irrigation flows would then have no losses based on criteria of diversity or uniqueness, though they would based on other criteria. However, if farming in the study area was relatively uncommon,and promotion of an agricultural way of life was considered desirable, then the significance of the loss of farm families or the loss of food supply could be evaluated in a similar manner to canoe stream miles.

There are obviously a number of other points that have to be defined or considered in relation to the use of uniqueness and diversity as I have used them. Unfortunately, there is not time now to dwell upon these; however some of these are: what level of scarcity constitutes a unique resource; what geographical area or areas should be considered in defining the state of uniqueness; and should all values be intrinsically equal? What I hope to leave you with is a feeling that the concepts of diversity and uniqueness are useful and quantifiable criteria; that they can be used, in conjunction with other criteria, as a sound and dependable basis for decision-making regarding the wise use of water resources; and that these concepts should be included in environmental impact statement evaluations.

CONCLUSION

In conclusion I'd like to address the two points raised by our panel organizer.

To the question, "Is the EIS a useful decision-making tool?" I would answer, "Yes, it could and should be - but it often is not."

More importantly, to the question, "Why or why not?" I would respond, "The basis reason that EIS's often do not clearly answer the "So what" of an impact is that they do not address <u>values</u> gained or lost, but instead provide data on parameters.

The remedy is for those that are involved in writing EIS's to structure them so that values gained or lost are clearly set out; and for those responsible for review to insist that EIS's contain this information in an easily understandable and verifiable form.

THE EIS: LITIGATION OR COMMUNICATION?

F. Budd Titlow
Bureau of Reclamation, Lower Missouri Region
Building 20, Denver Federal Center
Denver CO 80225

ABSTRACT

The value of the Environmental Impact Statement (EIS) in resource planning is obscured by litigation. Problem areas in the current EIS process are: lack of communication; unreasonable scheduling; inadequate project data base; complex format; and excessive volume. Maintaining continuous communication; revising schedules; acquiring a comprehensive, accurate data base; simplifying format; and reducing volume would improve the EIS. An improved EIS would be a valuable decision-making tool.

INTRODUCTION

Water resource planning is an extremely complex task—requiring an in-depth knowledge of the environment. What value does the environmental impact statement, or EIS, have in this process?

The EIS was promulgated by the National Environmental Policy Act of 1969, referred to as NEPA. According to NEPA "it is the continuing policy of the Federal government...to attain the widest range of beneficial uses of the environment without degradation... through utilization of a systematic interdisciplinary approach...in natural resources planning and decision-making". Clearly, the EIS was initially conceived as a decision-making document which would permit, whenever possible, simultaneous development and preservation of our natural resources.

In retrospect, the EIS has been anything but a decision-making tool. Soon after enactment of NEPA, the EIS degenerated into a "court vehicle" —a means whereby any proposed resource development could be temporarily halted. Indeed, litigation has become the byword of the EIS. The potential value of the EIS has been lost amidst the seemingly endless succession of environmental controversies.

Definitions of Terms

Several terms common to the EIS should be defined. An EIS is prepared by a team of professionals in a variety of disciplines including hydrology, wildlife ecology, aquatic biology, engineering, archaeology, recreation, botany, geomorphology, economics, and sociology. The project data base is the volume of information assembled by the EIS team for impact determination. The proposed project is the potential resource development analyzed in an EIS. Mitigation refers to any action which lessens the impact of a proposed project.

Several terms are introduced exclusively to develop ideas in this paper. "Outsiders" refers to any assemblage of concerned organizations or individuals not having a direct role in EIS preparation. "Communication" refers to transfer of information between the EIS team and "outsiders". "Decision-makers" are legislators and high-level bureaucrats who must make the ultimate decisions regarding resource development.

Problem Areas

The major shortcomings of an EIS involve: lack of communication; unreasonable scheduling; inadequate data base; complex format; and excessive volume. To aid examination of these problems, consider a hypothetical proposal to construct a 20,000 surface acre reservoir. This reservoir would be multipurpose, providing hydroelectric power, recreation, and flood control. The stream to be dammed flows through a spectacular canyon being considered for preservation as a wilderness area. This proposal, call it Project X, has been designated as a major Federal action requiring the preparation of an EIS.

Lack of communication. Communication with outsiders is presently limited to a 3-month review period scheduled just prior to the onset of project construction. Small wonder these people quickly become disenchanted and offer only negative review comments and project opposition. Their only recourse is legal delay, allowing time for independent project evaluations. Meanwhile, EIS team members patiently await the proffering of legal decisions, as project construction schedules are revised, contractual obligations are renegotiated, personnel are reassigned, and expensive court battles are waged.

Crash scheduling. Due to a lack of foresight, EIS preparation takes place in one year or less. This "crash schedule" allows EIS team members scarcely time to collect enough information to cram between two artistically designed covers. Opportunities for original data collection and analysis are obscured by a frenzied flurry of flying scissors, tape, editing pencils, and typewriters.

Inadequate data base. A project data base composed entirely of second-hand information, is not suited to reliable prediction and quantification of environmental change. Frequently, team members find a total absence of certain data. The hydrologist may discover there are neither streamflow records nor water quality measurements for the section of river to be dammed by Project X. This lack of information constitutes a data gap which seriously obstructs EIS preparation. Attempting to analyze the effects of Project X without streamflow and water quality data would be ludicrous. Unfortunately, circumvention of data gaps is the rule rather than the exception. Consequent EIS inaccuracies are impossible to defend in a courtroom.

Unwieldy format. The EIS format usually consists of ten chapters, one of which is entitled "The Relationship Between Local, Short-Term Uses of the Human Environment and the Maintenance and Enhancement of Long-Term Productivity". Careful study of this title is confusing to team members and readers alike. Yet the chapter remains. The title of this and other EIS chapters are extracted verbatim from NEPA. The intention of NEPA was not to create separate chapters with technical titles, but merely to ensure these topics are discussed.

Excessive volume. The typical EIS, 1000 pages or more, binds at least 50% of its material into the "Description of the Existing Environment". This represents the best example of wasted time, man-power, and materials in the entire EIS process. The majority of this information, such as a detailed description of geological strata and soil horizons, is irrelevant to determination of impacts and only adds volume to the EIS. Attempts at detailed analyses of all possible "Alternatives to the Proposed Action" also add unnecessary bulk.

Improvements

Increased communication. Communication is the keyword to an improved EIS. From the outset, EIS team members must solicit information and viewpoints from outsiders concurrent with data base collection activities.

Initial advertising by local media should include a description of the proposed project, as well as a schedule of weekly public meetings. These meetings should be open forums for transfer of information between team members and outsiders. Continuous communication would be mutually advantageous: each question or concern could supplement the project data base.

Reasonable scheduling. Preparation of an EIS should involve a minimum of two years. One year would be allotted to assembling the project data base while data base analysis and impact determination would take six months. The final six months would be divided equally between preparation and final review of the draft document.

Reliable, comprehensive data base. Initially, each team member must carefully verify and systematically file, by discipline, all second-hand information received. Examination of this preliminary data base will enable team members to delineate data gaps. The Project X hydrologist, having labeled streamflow and water quality "data gaps" would request additional information. Time and funding for original field research must be available in order to bridge these data gaps. Team members could either perform their own field surveys or supervise data collection by consultants.

Simplified format. The format and content of an EIS must be appropriate for the layman. Technical language, unique to a discipline, has no place in an EIS. Format should be revised to provide greater emphasis to discussion of impacts and resolution of associated problems. An EIS should consist of three sections: Introduction, Discussion of Impacts, and Problem Analysis and Solutions. The Introduction should contain a brief description of the proposed project and existing environment. The Discussion of Impacts should constitute the bulk of the EIS providing a detailed description and analysis of environmental effects. Impacts should be discussed by discipline but not classified as being beneficial or adverse. Introduction of individual bias into the Discussion of Impacts must be avoided. The reader should be allowed to make his own decisions regarding the nature of an impact. The same reservoir that holds scenic value to an engineer may represent a loss of natural beauty to an environmentalist.

The Problem Analysis and Solution section should first discuss the effects of mitigatory measures required by law or policy. Then problem areas generated by residual impacts should be detailed. Suppose that a reduction in streamflow caused by Project X development would significantly impact the scenic value and recreational use of the proposed wilderness area. Consequently, environmental organizations strongly oppose Project X. A suggested solution would have the power company sacrifice a portion of its anticipated energy output to provide a minimum flow through the canyon. In return, they would receive compensation from Federal and state recreation revenues and favorable publicity. Meanwhile, the environmental organizations must be willing to accept some reduction in scenic and recreational values. Providing a basis for derivation of such compromise solutions should be the main thrust of the Problem Analysis and Solution section.

Reduced volume. EIS volume would be reduced by simplifying format, including only relevant portions of the project data base, and discussing only viable alternatives. Chapters entitled "Unavoidable Adverse Effects", "Short- and Long-Term Uses of the Environment", and "Irreversible and Irretrievable Commitment of Resources", due to their repetitive nature, should be eliminated from the EIS. Each segment of the data base must be analyzed for relevancy in determining significant impacts. Suppose data base analysis indicates Project X would cause a 200 ft^3/sec reduction in streamflow during April. Such a flow reduction would decrease the spawning success of an endangered fish species by 50%. Accordingly, portions of the data base determining this impact should be included in the EIS. On the other hand, if analysis indicates maximum flow reduction to be less than 10 ft^3/sec, then a discussion of the relationship between streamflow and fish spawning would be unnecessary. The selection of all material for the EIS must follow this logical, systematic procedure. Insignificant impacts and the majority of the project data base should be assembled as supplemental material—available on request only.

If the EIS indicates Project X is environmentally undesirable, then an alternative would be selected requiring the preparation of another EIS. Therefore, a detailed discussion of the environmental effects of alternatives is unnecessary in an EIS. The only requirement is a brief comparison of the environmental feasibility of each alternative to the proposed project.

Benefits of an Improved EIS

What benefits would result from an improved EIS? Outsiders would maintain continuous rapport with natural resource planners and development proposals. Their frustrated opposition would yield to cooperation, and the need for massive revisions would be eliminated. Great savings in time and man-power would be realized.

The number of environmental lawsuits would be reduced. Project opponents would be oriented toward achieving compromise solutions. Suggestions and recommendations in the EIS would provide a basis for meaningful dialogue among dissidents.

Delays in project development would be reduced. If environmental problems appear insurmountable, a decision to scrap the project could be readily made.

Decision-makers and the general public would be provided with a concise, non-technical description of a project's environmental feasibility. Environmental guesswork in resource decision-making would be eliminated. Questions raised at project hearings could be answered with first-hand expertise. The EIS would finally become the informational vehicle intended by NEPA.

A means of ensuring the implementation of environmental safeguards would be provided. If protective stipulations outlined in the EIS were not being implemented then legal procedures could be initiated to stop project development. Herein lies the only value of litigation in the EIS process, a watchdog against unnecessary environmental degradation.

CONCLUSION

Continuous communication will avert litigation and promote solution in resource planning. The methodology for achieving simultaneous development and preservation of our natural resources is at hand. We must learn how to use it effectively.

TOPIC I-D.

WATER RESOURCES PLANNING AND THE ENVIRONMENTAL STATEMENT

Summary Discussion

The concept of water resource development for environmental concerns must be expanded. Environmental and natural resource agencies must be willing to accept the responsibility for implementing this development. Water resource development for environmental enhancement should be given the same accord as development for municipal, industrial, and agricultural purposes. There is a definite need for refinement of the principles of environmental engineering. Additional techniques for cost-sharing of environmental development proposals are needed.

The public interest must assume a greater role in resource development. Solicitation of public input should be a mandate. Obtaining public input from special meetings is often a difficult task. New techniques for encouraging public response should be developed. Increased utilization of advertising and the media would help to elicit public response. Inclusion of questionnaires in advertisements, complete with return addresses, would facilitate public response.

It should be emphasized that "no response" often signifies approval. Human nature evokes responses through dissatisfaction. Many government agencies (e.g., Bureau of Reclamation) are embarking on extensive programs to solicit and utilize public opinion. Government agencies should assume greater responsibility for administering the public trust. Lack of response to public interest constitutes a violation of trust under the precepts of equity law. Primary response to Federal and private developers must be avoided. More stringent legislation, especially regarding minimum flows, is needed in order to resolve complex problems encountered in water resource development.

Reducing EIS volume appears impossible, given existing standard operating procedures of the Federal Government. However, general acceptance of the concept that only relevant material should be included in an EIS would decrease volume in spite of government procedures. The EIS must become strictly an "informational vehicle." Decision-makers and the general public should not be provided with the entire EIS data base. Detailed analyses of environmental impacts are the responsibility of the EIS team members. The final document should provide only the conclusions and recommendations made by the EIS team. The professional judgment of EIS team members must be trusted. The EIS must analyze decisions which will be made in lieu of those which have already been made.

The EIS should include references to specific individuals. Direct responsibility for statements in an EIS should be assumed. This would facilitate the EIS review process by providing a basis for one-on-one interaction. More extensive use of existing information (e.g., State Comprehensive Outdoor Recreation Plans) should be made during EIS preparation. Often available information contains surveys indicative of public opinion.

The possibility of incorporating a discussion of environmental impacts into other documents (e.g., Bureau of Reclamation planning reports) should be considered. This would eliminate the "duplication of effort" that often results from the preparation of separate documents.

Notes by panel moderator: F. Budd Titlow
Bureau of Reclamation
Lower Missouri Region
Denver, CO

INSTREAM FLOW NEEDS: THE ECONOMIC CASE FOR NAVIGATION

Ken L. Casavant and James R. Jones
Departments of Agricultural Economics
Washington State University and University of Idaho
Pullman, Washington and Moscow, Idaho

ABSTRACT

The paper looks at the trade-offs between navigation outputs and other uses of multiple-purpose river systems. Certain costs such as the opportunity cost of possible foregone energy resulting from lockage are identified. Some of the benefits derived from navigation are enumerated. Finally the paper raises some of the types of questions that require further research.

INTRODUCTION

We welcome this opportunity to talk about transportation and its benefits and costs. This conference is going to be examining the alternative uses of instream flows of water. Alternative uses may have competitive, complementary, or even supplementary relationships. And, these relationships may arise in the traditional case of diversion uses versus instream uses as well as within instream uses. Navigation use of instream water can certainly become competitive with diversion or out-of-stream water uses and possibly with power generation uses. At the same time, navigation uses may well be complementary or supplementary with traditional instream considerations such as recreation, fish and wildlife, water quality, etc.

The overall purpose of this paper is to establish an approach generally outlining navigation benefits and costs and potential trade-offs with other uses. In achieving this purpose, the paper is structured to reflect several sub-objectives: (1) the costs, especially opportunity costs of foregone power associated with providing the necessary water for navigation will be presented; (2) a review of the general types of benefits ascribed to navigation will be undertaken with Pacific Northwest history and the recent Lewiston experience serving as examples; (3) the potential impact if navigation is hindered on a seasonal basis will be explored; and (4) navigational uses that will result from new technological developments in inland transportation will be identified. The emphasis throughout our paper will be to indicate direction and type of costs and benefits, rather than specific magnitudes, thus allowing some general conclusions to be reached.

COSTS OF PROVIDING FOR NAVIGATION

A consistent theme in the transportation literature is the controversy concerning efficient allocation of resources between modes as society strives to move that which it produces. Public provision of navigation facilities has always been a bone of contention between railroads who contend they provide their own way, but tug-barge navigation firms don't. The costs associated with that question are the costs of operating and maintenance of locks on the dams. While these costs (the physical costs of opening and closing the locks have been estimated at $35-$40 per lockage[1]) are real economic costs, they are not specifically competitive with other instream flow uses. The water used in locking freight-carrying barges up and down stream is directly competitive to other uses, particularly energy generation. The opportunity cost of foregone energy when adequate water is not available is definitely a competitive situation.

Water used for lockage can be water lost to energy production. The amount of water per lockage in a 86 foot by 675 foot lock with an average lift of 80 feet is 107 acre feet.[2] With this coefficient, and projections of tonnage to be moved on the river it is possible to approximate the number of lockages required per year. For example, with an average tonnage per lockage of 3,000 tons and a projected 500+ million tons of cargo in Bonneville locks in 1975, 1,718 lockages would be required. Thus, 183,826 acre feet of water have been removed from potential energy production for Bonneville Dam alone. If it is assumed that 90 percent of the total tonnage also goes through The Dalles, McNary, and John Day dams, the water required for navigation increases to almost 500,000 acre feet of water on the Columbia River system alone. Dams on the Snake, while handling less of the total traffic, would remove water in the same proportion.

The potential electrical power loss can then be quantified. It has been estimated that replacing energy lost when water is diverted for other uses

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[1] Port of Lewiston - Navigation Water Needs to Lower Snake River to Lewiston, Report prepared for State of Idaho Water Resource Board by CH_2M-Hill, April 15, 1970, page 14.

[2] The Army Corps of Engineers has underway a study of instream flow levels on the Columbia-Snake River systems. The study, under principal investigator Rob Vining, has been underway about 18 months and is within a month or so of completion. We do wish to thank Rob for his help in preparation of the followin cost data in this paper.

(in this case navigation) and no dam spillage is in process, would cost about 20 mills per kwh.[3] The kwh produced by water is based on how the water is shaped, meaning how far and how fast it moves through the dam and turbines. An acre foot of water dropped through one foot of head generates .87 kilowatt-hours of electricity.[4] Thus, the kwh/cfs coefficient is 4.0 at Bonneville, 5.6 at The Dalles, 7.7 at John Day, 4.4 at McNary, and 5.6 on the dams on the Snake River.[5] When the acre feet of surface water is converted into cfs at about 723 acre feet per cfs, calculation of the opportunity cost of water used for navigation is possible.

For example, if Bonneville's flow in 1975 uses 183,000 acre feet or 254 cfs, and 4 K/W per cfs can be realized at Bonneville, the annual loss is 1,016 K/W of generation in an hour. On an annual basis a maximum of almost 9 million K/W hours could be lost. At 20 mills/kwh replacement cost, navigation on Bonneville alone in 1975 cost $18,000 in lost energy. Such a costing sequence can be used to estimate energy lost as traffic moves further up the river into Idaho, requiring repeated locking. For all movements on the Lower Columbia River, the total potential energy lost in 1975 is estimated at 44.7 million kwh[6] or almost $90,000. It should be noted that, unlike diversion of water for irrigation, navigation allows water to be reused at points further down the river and thus is a non-consumptive use of water. Also, the above analysis does assume no spillage is occurring.

BENEFITS ASSOCIATED WITH NAVIGATION

The obvious benefit from navigation is the cost savings on transportation rates for those commodities moving on the river. The not-so-obvious benefit is the cost savings on commodities moving on rail rates that have been substantially lowered due to competition from barge rates and service. Thus, commodities and shippers who never use water transportation still benefit from the availability of navigation on inland rivers. The movement of PNW

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[3] Whittlesey, Norman, A Planning Study for Irrigation Development, report to Washington State Legislature, Department of Agricultural Economics, Washington State University, January 1976.

[4] Hamilton, Joel R., Irrigation Water and Energy Use in Idaho: The Social Costs of Average Cost Pricing, unpublished manuscript, University of Idaho.

[5] Vining, Rob, Army Corps of Engineers, unpublished data.

[6] Ibid.

wheat is a classic example of this competitive relationship. The distribution of this movement by mode is reflected in Table 1. The total movement of wheat has increased from about 182 million bushels in 1965 to 323.5 million bushels in 1975. Barges have moved an increasing amount, both in absolute volume and relative to other modes, increasing from 15 percent in 1966 to a high of 31 percent in 1972. Even though its relative share has decreased from that 1972 high, its absolute volume has continued to increase.

The historical grain rate structure in the PNW does straightforwardly indicate the impact and benefits of improved navigation. Indicated in Table 2 are the rail rates for Whitman County (in Southeastern Washington) from 1931 to June of 1975. The most interesting fact is that as late as 1973 we were moving grain at a rate 2 cents per hundredweight lower than the 1931 rail rate of 24 cents, and 23 1/2 cents lower than the 1958 rate of 45 1/2 cents. The substantial rate reductions occurred because of the truck-barge and truck competition.[7] It should be noted that the McNary Dam and Locks were opened in 1953, The Dalles in 1958, and John Day in 1963, corresponding to the 1958 and 1968 rail rate reductions. The opening of the Snake River dams--Ice Harbor prior to 1964, Lower Monumental in 1969, Little Goose in 1970, and Lower Granite in 1975, have and can be expected to increase the area of geographical rate competition.

The extension of slack water navigation to Lewiston, Idaho, by the Lower Granite Dam allows further quantification of the benefits of navigation. A study presently underway led by Bob Thayer in the Department of Agricultural Economics at Washington State University has identified the marketing savings realized by shippers of wheat on the Snake River due to the advent of Lower Granite Dam. On a total volume moved of 10,727,603 tons, savings of $2,155,651 (out of a $128,835,323 total marketing charge) were realized on grain moved on the river. Principal areas gaining from the Lower Granite were, as expected, Eastern Washington, Montana, and Idaho.

The transportation model used in the WSU study also indicates potential savings if rates are reduced in the future by railroads, as has historically happened, to compete with this truck-barge movement. If such a competitive reaction by the railroads were in the form of a 10 percent reduction in rail rates from Montana and Southern Idaho, an additional savings (benefits) of

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[7] Casavant, Kenneth, <u>An Economic Evaluation of the Competitive Position of Puget Sound Ports versus Columbia River Ports for Pacific Northwest Wheat Exports</u>, unpublished Ph.D. dissertation, Washington State University, 1971.

Table 1. Receipts of wheat at Puget Sound and Columbia River Ports by mode, selected years (in 000 bushels).

Crop Year	Rail	%	Truck	%	Barge	%	Total
1964-65	135,949	75	12,011	7	34,030	18	181,990
1965-66	143,606	78	13,167	7	27,352	15	184,125
1966-67	125,289	73	15,351	9	30,494	18	171,134
1967-68	153,189	78	15,678	8	27,206	14	196,073
1968-69	142,559	74	9,878	5	39,461	21	191,898
1969-70	161,687	73	10,533	5	47,611	22	219,851
1970-71	152,469	72	11,096	5	49,641	23	213,206
1971-72	135,792	66	6,777	3	63,726	31	206,295
1972-73	219,205	70	11,707	4	80,313	26	311,225
1973-74	247,769	77	13,156	4	63,973	19	324,898
1974-75	224,317	69	18,740	6	80,404	25	323,461

Source: Brennan, Cecil, Opening Statement on Ex Parte No. 270 (Sub II9), Investigation of Railroad Freight Rate Structure--Grain and Grain Products, Pacific Northwest Grain and Grain Products Association, March 1, 1976, Appendix P.

Table 2. Rail rate from Whitman County to Portland and Seattle, selected years, cents per 100 lbs.

Year	Rate
1931	24
1939	23
1949	34 1/2
1958	45 1/2
1961	26 1/2
1966	26 1/2
1967	29 1/2
1968	21
1970	25 1/2
1972	21
1973	22
1974	26
1975	28 1/2

$3,439,614 would be realized by PNW wheat shippers. Such a rail reduction would cause an increase in rail movements of 1,430,060 tons and an increase in rail gross revenues of slightly over $24 million. The strong response indicates the close competitive relationship surrounding navigation in the PNW. This example becomes particularly relevant since the Union Pacific in Southern Idaho and the Burlington Northern in Montana have recently requested rate reductions in a magnitude of 10-15 percent.

These type of cost savings are the most readily identifiable benefits available from navigation. Additional benefits arise in the form of economic development in the service sector associated with navigation activities. Lewiston, Idaho, has two new grain transshipment terminals, new docks, activities of new barge companies, etc. affecting its economy. Motels and gas stations have reported effects of increased trucking in the area. The creation of a hub of economic development reaching far into the hinterlands is a definite impact of navigation availability.

These have been acknowledged and familiar benefits of navigation use of instream flows. A further impact of not having year around navigation can be hypothesized. If, because of competitive use of the river, navigation becomes infeasible for a given period of time, the railroads have a unique pricing precedent available to them. The Great Lakes in the Midwest are frozen over during some winter months. In Investigation and Suspension Hearing 8899, Division 2 of the ICC has found new unit-train rates on wheat from Minneapolis and Duluth to Martins Creek, Pennslyvania, to be just and reasonable. These rates have different levels during the seasons of open and closed navigation on the Great Lakes. It is a distinct possibility that if navigation were to be seasonably affected by competitive in or out of stream uses, such a railroad pricing scheme would be experienced in the PNW. A possibility based only on supposition, but still a possibility.

FUTURE NAVIGATION USES

A series of recent technological innovations in inland navigation and cargo handling systems may increase the benefits of water used for navigation by adding a new dimension of activity on inland waterways. Traditionally, the barge mode of movement has been restricted to bulk commodities such as grain, petroleum, ore, limestone, pulpwood, and fertilizer. The recent development of intermodal containers now allows barge movement of commodities requiring mini-bulk or breakbulk techniques of handling and transport. Thus, a much larger variety of commodities can be moved by low-cost barge transport in the future. The most significant of these techniques are container carrying barges and LASH barges.

Barges designed to carry containers can handle several containers, each with different contents so that combinations of bagged, palletized, or loose commodities can be hauled on a single barge. Containerized cargo movement generates savings by reducing the number of times that each unit of cargo is rehandled or transferred from one mode to another. The intermodal container unitizes cargo so that it isn't rehandled from the point of debarkation to final destination.

LASH (Lighter Aboard Ship) is a further extension of the intermodal container concept. This method involves an integrated system where barges are taken from inland points to a mother ocean vessel anchored at the mouth of, e.g., the Columbia River. At this point the barges are loaded directly onto the ocean vessel, thus serving as a mobile container. In this sense the statement that slack water navigation gives an inland point, such as Lewiston, direct ocean access takes on a literal interpretation. Inland points become the final ports in transoceanic movement of cargo. Thus, the implications for future navigational uses of instream water become even more promising.

All studies conducted to date on the projected value or benefits of barge navigation predate these coming innovations and therefore have failed to account for the full potential benefits offered by commercial navigational use of the Columbia-Snake and other inland waterways. A recently initiated study at the University of Idaho will be looking at the potential benefits tobe derived from these systems in the Pacific Northwest.

CONCLUSIONS

The authors caution the audience not to misinterpret the above remarks. We do not wish to pretend that we have adequately outlined the full extent of benefits and costs of instream flow navigation uses. Rather, these are prefactory comments about some of the types of benefit and cost issues that are relevant in the context of this conference. Our aim up to this point in the discussion has been to point out that there are benefits, as well as costs, to be associated with navigation uses. Secondly, we hope we have identified some of these costs and benefits. Finally we would like to go one step further by suggesting some of the types of questions that require further research before we can resolve what the status of navigation will be in the future allocation of instream flow priorities for recreation, power generation, fisheries, navigation and irrigation uses:

1. Further research is needed to conceptualize the methodology for measuring the relationship of the other instream flow uses to navigational uses. To date there are many unanswered questions and the authors admit they have only made a marginal contribution today.
2. Explicit consideration needs to be given to the seasonal aspects of water flow and commodity flow in measuring the benefits and costs of navigation.
3. Environmental questions such as the relationship between lockage use and anadromous fish runs need clarification.
4. Will diversion of water from the lower Snake and Columbia rivers for irrigation purposes compete with navigation instream flow needs, and if so, when?
5. Do present pricing practices reflect the full costs and benefits of alternative uses of instream flow resources to society?

In summary, assessment of instream flow needs requires consideration of costs imposed by, and benefits derived from, navigational usage. We hope we have presented some tentative answers regarding some of these benefits and costs. Further, we hope we have helped point the way to a more conclusive treatment of the trade-offs which exist between navigation and the other outputs of a multiple use river system by suggesting some of the questions that need further clarification.

ECONOMIC PERSPECTIVES ON INSTREAM FLOW REQUIREMENTS FOR RECREATION

Clynn Phillips
Associate Director
Water Resources Research Institute
University of Wyoming
Laramie, WY 82071

ABSTRACT

The level of research effort on biological, hydrological and water quality relationships to instream flows has not been achieved for general recreation. Modification of existing streamflow regime is likely to cause economic effects among present streamflow users that will generate pressure against the proposed modification. For many western rivers, the present flow regime is institutionally set through the appropriation of water rights. The opportunity to modify streamflows may be seriously limited where most of the streamflow has been appropriated. Irrespective of the institutional constraints on modifying streamflows, public support and public action for modification is not likely to occur until instream flow requirements can be converted into some measurement of value. There is need to identify the products of controlled or modified streamflows (i.e., enhanced fishery, increased recreation opportunities, improved water quality, enhanced aesthetic qualities, etc.), and to determine the value of these products. When the benefits of various instream flow requirements are understood in terms of their relative value, the case can be developed for the allocation or reallocation of streamflows for fishing, recreation use, aesthetic enhancement, water quality control and other beneficial uses.

INTRODUCTION

For those of you alert to the ways of academia, you will have guessed by my title that I have nothing new to report. The tipoff, of course, comes in my use of the term "economic perspective." Whenever we from the Land of Academia cannot approach the speaker's rostrum with legitimate research results to report, you can generally expect some topic or issue to be (1) revisited, (2) overviewed, (3) given a perspective, or (4) approached philosophically. These terms represent a very distinct and ordered set of states of wisdom. Assistant professors are only allowed to revisit a topic or issue if they have nothing scientific to report. If after an appropriate probationary period an assistant professor is judged by his peers to be worthy, promotion to the rank of associate professor occurs which, among other things, certifies the holder of such rank has mastered a level of wisdom that permits the person to overview.

The third state in this progression, the mature skilled state, is commensurate, of course, with the rank of full professor and is explicit certification that such person is qualified in the use of wisdom without restriction. While there is social recognition that the progression continues up through the philosophical approach state (the exclusive right and privilege of administration) the peculiar behavior of this group sometimes suggests serious wisdom contamination. Indeed, those of you close to academia have undoubtedly heard claims of discovering evidence of administrative eutrophication (i.e., an accelerated aging process caused by excessive nutritive contamination). Most generally these charges are voiced from within the revisited group.

Before proceeding with an illumination of the economic perspectives on instream flow requirements for recreation, my candidness calls me to alert you to one other observation. When unprepared with scientific fact, the academic maintains an obvious demeanor of objectivity by scientifically converting first-person biases and opinions into third-person evaluations and assessments. Thus, to revisit, to overview, to approach philosophically, or, as in my case, to present a perspective is to shroud or conceal the substance of private opinion in the cloak of third-person scientific objectivity. This is not to suggest this process is a meaningless ritual; no, indeed, it is necessary in my case to give me some distinction from you in the audience. To proceed with this assignment in an orderly manner, it is necessary that you, the audience, recognize my opinions as perspectives and that any reaction, reply or rebuttal that you may wish to make can only be considered as an opinion.

The above comments are, of course, fallacious and were intended to be facetious. They are not intended to be an indication of the importance I attach to the subject. Rather, they reflect the irritation and frustration I experienced as I prepared for this assignment. The irritation was caused by a realization that I could draw little from having spent the past ten years of my research life on the economics of recreation, fish, and wildlife resources that would contribute much to our understanding of instream requirements and instream flow values. It was irritating also to find that few other economists were dealing with the economics of instream flow requirements for recreation.

The irritation rapidly advanced to a state of frustration as I tried to bring the instream requirements work of other disciplines into an economic context. Let me state, with emphasis, that my motive for subjugating the instream flow work of other disciplines to the scrutiny of economics was to assess that possibility of measuring or inferring values from the physical and biological work that has been accomplished and to relate these values to resource allocation decisions. Since resource allocation is the subject of economics, decisions to allocate or reallocate resources must be considered as economic acts. Moreover, it is a rare resource management agency that does not have to justify its program on economic grounds. One would presume, therefore, that recommended actions or programs on the part of resource management agencies would be presented or addressed in terms amenable to the criteria to which the recommended action would eventually have to be justified. I could not readily extract an economic rationale from much of the instream flow requirements research that I reviewed in preparation of this assignment. To this situation, I should like to address several economic perspectives.

PERSPECTIVE NO. I

There is a strong resource endowment theme in the instream flow literature that can only complicate if not outright impede a fair and open consideration of the resource allocation, or reallocation, that is implied in most instream flow requirements studies. There are few streams, in the western part of the nation at least, where the flow resources are not committed to present uses. To imply or suggest that the present stream regime should be altered to protect or enhance an aquatic species or to facilitate participation in a particular recreation activity without stating the criteria on which the judgment was made, places the recommendation in an operational vacuum. Where the present water flow of a stream is appropriated, including storage of high water flows, alteration of the flow regime would be tantamount to confiscating and redistributing the property rights of present users.[1] In most western states, the law would protect the rights of present users against an arbitrary and involuntary transfer of water. There are, of course, situations where condemnation of water rights is allowed, but only through the "due process" and "just compensation" provisions of the law.

The rapture expressed by resource endowment advocates that "God intended streams to be free flowing" or that severely reduced streamflows on controlled rivers is a "crime against nature" neither establishes legal precedence nor creates conditions for negotiation. With no intent to appear profane, present

[1] For a discussion of property rights and their effect on resource values, see John V. Krutilla and Anthony C. Fisher, The Economics of Natural Environments, Johns Hopkins University Press, Baltimore, Maryland, 1975.

western water law would just about require God and Mother Nature to prove they had water rights preferential to other users. Even if one or both of the above claimants decided to take their case to court, it would undoubtedly have to await settlement of the reservation claims that have been made by Indians and the Forest Service, a situation that would likely put off litigation for several decades.

It appears that neither the courts nor a majority of society share the "obvious good" or "inherent value" claims for instream flow requirements that are typically advanced by resource endowment advocates. While this situation may be an indication of naiveté on the part of the courts and society, there is need for the resource endowment advocate to substantiate his claim with objective evidence that can be used to support a modification of present instream flow regimes. This is not to suggest that the benefits of increased minimum flows need to be expressed necessarily in dollar terms. There are, nevertheless, values involved in the trade-offs that will be made and the resource endowment advocates ought to get on with the job of identifying causes and effects.

PERSPECTIVE NO. II

There is a corollary to the resource endowment approach that could be labeled the program or activity endowment approach. In this case it is apparently presumed that the inherent worth of the program is obvious and should be assigned property rights to resources needed for support of the program. An example of this approach is the broad sweeping inventory program designed to locate resources with characteristics suited to the requirements of the program. These inventories are apparently approached with some notion of a reservation doctrine in mind. The advocates of this approach must presume that the value of the program they represent will claim the use of the inventoried resources (or a significant proportion of them) from other competing uses and will justify the cost of conducting the inventory.

While I am somewhat timid about challenging specific proponents of the resource endowment approach because they overwhelm me with such arguments as the threat to rare and endangered species and to irretrievable losses to the world's genetic pool I am not so intimidated by the program endowment approach proponents and I wish to take issue with a report that is likely to have considerable influence on the group attending this conference. In particular, I find the section authored by Andrews, Masteller, Massey, Burdge, and Madsen in a recent U.S. Fish and Wildlife Service publication entitled, Methodologies for the Determination of Stream Resource Flow Requirements: An Assessment,[2] to be an example of the program endowment approach. They conclude that "a standard method of stream classification should be agreed upon and applied on a nationwide basis."[3] While this recommendation is tempered later when the authors acknowledge that such a task would be "formidable," there is no indication that recreation is considered a competing use or that economic and institutional constraints would rule out, on a practical basis, any possibility of regulating streamflows to maximize or even enhance the recreational use of some streams. Unless one considers recreation to be a merit good of such high value that all other uses would be subordinate to it, then even a vague notion of demand would suggest that some practical criteria ought to be developed to screen and prioritize the list of streams that would be inventoried.

The recommendation that all streams in the nation be inventoried according to some type of recreation classification system could entail several evaluations if the requirements of the various water-based recreation activities were to be treated specifically and in a commensurate fashion. The flow requirement for white-water canoeing is different from the requirements best suited for swimming. It is difficult to understand a recommendation for a nationwide inventory and classification of streams for recreation purposes without some explicit awareness of economic reality, especially considering the scope of the task that would be involved. It is particularly grievous in that the authors are all social scientists and would be familiar with demand concepts, as well as those of supply, and ought to have been in a position to cast their discussion in some semblance of benefit/cost analysis.

The program endowed claim on resources suffers from the same lack of focus on reality as does the resource endowment approach. The two approaches represent, in essence, opposite sides of a coin. The worth of either approach separately of their combined worth has never been demonstrated to be of much value in the resource allocation market place. A devaluation of the currency of both approaches by their respective proponent groups would probably prove beneficial to recreation interests in the long run.

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[2] W. H. Andrews, et al., "Measuring the Impact of Changing Streamflow on Recreation Activity," Methodologies for the Determination of Stream Resource Flow Requirements: An Assessment, C. B. Stalnalser and J. L. Arnette, Eds. U.S. Fish and Wildlife Service, Western Water Allocation, Denver Federal Center, Denver, CO, 1976.

[3] Andrews et al., page 163.

PERSPECTIVE NO. III

"Recreation is recreation is recreation," is not a truism. The motivation to participate in recreation and the products derived from recreation are many and varied.[4] There is need to understand recreation/resource interactions in terms of motivations and products. Until these relationships are understood, it will be difficult to assess recreation resource requirements in the context of social and/or economic needs. With the supply of outdoor recreation areas and facilities generally being provided by public agencies at zero or near zero prices to the participant, caution has be be exercised in trying to extrapolate from participation figures alone the public benefit that is being created by the provision of recreation facilities. A corner drug store special offering a 5¢ strawberry ice-cream cone in comparison to a cost of 25¢ for all other flavors creates a consumption pattern that will suggest a strong preference for strawberry ice-cream when, in fact, that may not be the case. There is no obligation on the drug store proprietor to continue selling strawberry for 5¢ a cone just because consumption increased tremendously. Neither is there an inherent obligation to manage streamflows in a manner that will benefit recreation use even though it might be shown that a stream has the physical and aesthetic characteristics to attract a large number of recreationists if the flow regime could be changed.

The instream flow requirements for the various water-based recreation activities cannot be considered to be of equal value or to be ranked in relative value according to the proportionate number of participants that engage, or will likely engage, in each activity. There is ample evidence that recreationists make trade-offs between activities and still find satisfaction, just as a person derives satisfaction from the purchase of a new Ford after deciding that a new Lincoln was too expensive.

While the need for rigor is apparent in the allocation of resources between recreation and other competing uses and in the allocation of resources among the various activities within recreation, the analytical techniques available for making these allocations are incomplete, at best. Economics does not have its head on straight, completely and firmly, with regard to resource evaluation. The oft-heard criticism of economic evaluation studies is still a nagging truth: not all values can be quantified.[5] There are

[5]Chapters 1 through 4 of Krutilla and Fisher, The Economics of Natural Environments, presents a review of both conceptual and empirical problems that persist in the valuation of recreation resources.

problems with the definition and measurement of recreation values and with the identification of the recipients of those values. Recreation's claim on resources will always be questionable if for no other reason than the subjectivity that supports methods of measuring the intrinsic value of recreation and amenity resources.

Economists, including myself, are quick to point out that participation trends alone are not sufficient to justify the commitment of resources to recreation uses. An economic caution sounded frequently in the ears of resource managers is that the ability to demonstrate the likelihood of capacity participation for a planned recreation area or facility development is not necessarily an indication that benefits exceed costs when the area or facility is being provided at no direct cost or little direct cost to the participant. At the same time that economists are having difficulty demonstrating the value of recreation and establishing a viable claim on required resources, Congress and most states' legislatures are acting on an apparent expressed public need for additional recreation opportunities. This inconsistency suggests that the economic techniques being used to value recreation resources still include significant deficiencies as evidenced by the general inability of recreation valuation studies to track the public mood. Until the conceptual and methodological problems with present evaluation techniques can be resolved, perhaps economics would find itself less frequently in defensive positions if more effort was devoted to identifying the least costly or most cost-effective means of providing public recreation opportunities. As previously stated, there is need for improved methods of allocating resources within recreation and this task must proceed irrespective of whether the level of resources committed to recreation vis-à-vis all other competing uses can be economically justified.

PERSPECTIVE NO. IV

As a general statement of public policy, resource managers have been pressured continually to produce more, to manage better or to accommodate just a few more people. The biological capacity of many resources has been reached and, in some cases, exceeded. The American way of finding a scientific means to remove the constraints or increase the capacity can no longer be counted on to solve all resource scarcity problems. Rather then concentrating on methods of increasing output, it appears that resource managers will be devoting more effort to programs that limit use. In particular, there is need to find ways of relieving the pressure on certain limited resources. Before resorting to programs that establish use limits--programs that have a tendency to discriminate as well as limit--there is need to assess the possibility of developing programs that will entice recreationists away from pressured resources and still maintain a system of relative free choice. We know, for example, that recreationists shift from activity to activity or vary their rates of participation (consider the current popularity of tennis) for no apparent external reason.[6] If we understood the substitutability that exists between any two recreation activities, it would likely point to ways of alleviating pressure on certain limited resources that are not presently being considered. It may be that subsidized green fees at a local golf course is both the most effective and least costly means of alleviating an excess of fishing pressure on a nearby stream, or that the development of attractive camping facilities at an underutilized location is an effective means of shifting pressure from an overused location.

The notion of substitutability in recreation is a rather recent focus of recreation research.[7] It will be elusive until the nature of recreation is better understood; particularly, it has to be better understood in terms of its relationship to natural resources. The notion of substitutability will require some adjustments in traditional agency/clientele relationships as well. The task of getting an agency to discontinue seeking support from a group of recreationists that the agency will no longer serve may be more difficult than the task of getting the recreationists to shift locations or change to new activities.

With respect to the last perspective, I wish to present some selected data sets from a study that Sheryl Ferguson and I are conducting for the Wyoming Game and Fish Department.[8] The study is still in progress and the

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[6]There are, of course, shifts in activity participation that can be explained in terms of external changes. Development of a new recreation opportunity (like a new reservoir) or new equipment that makes participation easier (the mobile camper) will increase participation in the affected activities and probably decrease participation in competing activities.

[7]John C. Hendee and Rabel J. Burdge, "The Substitutability Concept: Implications for Recreation Research and Management," Journal of Leisure Research, 1974, 6(Spring), pp. 157-162.

[8]The principal objectives of the study are to develop expenditure estimates for hunting and fishing activities in Wyoming and to identify the attitudes and preferences sportsmen have for certain aspects of the hunting and fishing experience. The study is to be completed by June 30, 1976.

data that will be presented will have to be considered preliminary. Furthermore, the sample and questionnaire designs were intended only to develop descriptive profiles of Wyoming fishermen and not the purposes for which I will use the data in the following discussion.

One of the objectives of our Game and Fish study was to develop attitudinal profiles of Wyoming hunters and fishermen that had management implications. The nature of these profiles had been generally determined in a series of discussions with Dr. Doug Crowe and John Baughman, big game and fisheries planners, respectively, for the Wyoming Game and Fish Department when the work of Potter, Hendee and Clark[9] in the state of Washington was brought to our attention. The results of their efforts to group deer hunters into meaningful hunting factor groups prompted us to contact Dr. Bev Driver, Recreation Behavioralist with the Rocky Mountain Forest and Range Experiment Station in Fort Collins, Colorado (a Forest Service colleague of Dr. Hendee's) to discuss the possibility of using a similar technique in the Wyoming survey. Dr. Driver and Dr. Perry Brown, Colorado State University, assisted us with the development of an appropriate set of attitudinal statements. The respondents were asked to indicate on a five-point scale (extremely important, very important, moderately important, of little importance, or not at all important) how they felt about each statement.

I will not take time to explain the statistical technique utilized to identify the factor groups listed in the following tables, other than to indicate that it is called cluster analysis.[10] It should be emphasized that it is not the statistical technique that names or labels the factor groups; rather, it is the analyst or researcher that selects the label based on his interpretation of what the various sets of statements mean. I realize I have given you a sketchy explanation of the methodology--this you can examine when the study is published--what I hope to do in this presentation is to demonstrate the potential of this analysis as a resource management aid. The data are taken, with one or two exceptions, from our survey on nonresident

[9] Dale R. Potter et al., "Hunting Satisfaction: Game, Guns, or Nature," Human Dimensions in Wildlife Programs, John C. Hendee and Clay Schoenfeld, Eds., The People/Natural Resources Research Council, 4507 University Way, N.E., Seattle, Washington 98105, 1973.

[10] We made some adjustments in the fishing factor groups identified through cluster analysis. The adjustments resulted in the identification of factor groups having straightforward management implications. An explanation of the adjustments will be included in the final study report.

seasonal fishing license holders.[11]

Table I contains a list of the factor groups--as we named them--that were identified in the cluster analysis and the relative size of the factor groups within Wyoming's three major fishing license categories.

Table I. Relative size of factor groups for non-resident seasonal, tourist, 5-day, and resident license samples, 1975

Factor Groups	Non-Resident Seasonal (%)	Tourist 5-Day (%)	Resident (%)
Trophy	15.0	8.6	7.7
Wild Fish	19.6	20.6	16.9
Yield	17.7	15.6	19.1
General Recreation	16.7	18.8	29.8
Solitude	31.0	36.4	26.5
Total	100.0	100.0	100.0

The distributions are generally consistent with what would be hypothesized. The nonresident seasonal license group would be expected to be more interested in trophy and wild fish and generally less interested in yield and general recreation than resident fishermen as a group. A majority of the nonresident seasonal license holders live in adjacent states (primarily Colorado, Utah and Nebraska) and come in pursuit of fishing qualities they feel are available to them in Wyoming. The state's reputation for trout fishing is an attraction for the trophy and wild fish groups, whereas those fishermen interested in yield or general recreation can probably find opportunities suited to them in their respective states.

The time and expense involved in coming into the state to fish several times during the year would tend to screen out the passive or casual fisherman and, consequently, the factor group distribution for the nonresident seasonal license holder would be weighted toward the more "serious" fisherman. The relatively low cost of a resident fishing licence allows the casual, the indifferent and perhaps even the disinterested person to purchase a fishing license even if it is strictly for convenience or a one-time situation. The

[11] This license group of fishermen would be most apt to exhibit the behavior expected from each factor group. Convenience and distance are not overriding considerations in the selection of a fishing area as they are with resident fishermen. The trip purpose of nonresident seasonal license holders into Wyoming tends to be primarily for fishing, whereas the trip purpose of the tourist 5-day license group is frequently oriented to general recreation and tourist activities.

relative size of the general recreation factor group (Table I) under the resident license category undoubtedly reflects the low entry cost of fishing. As the data in Table II indicate, the trophy and wild fish groups apparently have a greater commitment to fishing than either the yield or general recreation group as shown in the average number of days fished.

Table II. Number of days fished on Wyoming waters by factor groups, 1975

Factor Groups	Days Fished NRS License	 Resident
Trophy	16.4	18.7
Wild Fish	15.3	16.8
Yield	14.6	12.8
General Recreation	13.6	11.4
Solitude	14.8	13.3
Sample Average	14.9	13.6

The tourist 5-day license category represents the least cohesive group of the three. While a significant number of 5-day licenses are sold to residents of adjacent states, the bulk of the 5-day licenses are sold to general tourists. There are undoubtedly many experienced fishermen in the 5-day group and many of the parties came to Wyoming specifically or primarily to fish. On the other hand, approximately 50 percent of the tourist 5-day respondents indicated that fishing was incidental to their Wyoming visit.

After identifying the factor groups, the next task was to see if the respective groups displayed differing preferences for fishing that might have management implications. This analysis was made by calculating and comparing the average score for the five factor groups on each of the twenty-two attitudinal statements that was included in the questionnaire. These scores are presented in the next five tables.

The first of these tables, Table III, includes four attitudinal statements that received high markings across all factor groups. With 1.0 being the lowest score or least important ranking possible and 5.0 the highest score or most important ranking possible, an average score of 3.0 would be the midpoint of the scale. The scores in Table III are all above 3.0 and suggest that the conditions implied by the four attitudinal statements were common to all fishermen or that the conditions were basic to fishing. The variation among the factor group scores indicates that while these conditions were relatively important to all fishermen, some factor groups attached greater importance to some conditions than did other groups. It is logical, for example, that the yield group attached greater importance to "getting good eating fish" than did the trophy factor group.

Table III. Important aspects of fishing[a] across all NRS license factor groups, 1975

Attitude Statement	Trophy Group	Wild Fish Group	Yield Group	General Recreation Group	Solitude Group
Being able to relax	4.29	4.26	4.33	4.06	4.50
Being a well-equipped fisherman	3.50	3.40	3.43	3.13	3.32
Just being outdoors	4.20	4.21	4.11	4.18	4.41
Getting good eating fish	3.62	3.66	4.31	3.81	3.66

[a]High average scores on the attitudinal statement.

A set of four attitudinal statements were ranked as being relatively unimportant by all factor groups. These statements are listed in Table IV. Again there is variation among the factor group scores and the differences are generally consistent with what might be logically assumed. The statement "opportunity to develop or improve fishing skills" was included in this table even though only two of the factor groups scored it below the mid-range value. The reasons for including it in this table were that the management implications of this statement were vague and the statement was not closely related to the set of statements in either of the three remaining tables.

Table IV. Aspects of fishing considered to be relatively unimportant[a] across all NRS license factor groups, 1975

Attitude Statement	Trophy Group	Wild Fish Group	Yield Group	General Recreation Group	Solitude Group
Showing fish to family	2.20	1.81	2.09	2.01	1.95
Opportunity to develop or improve fishing skills	3.04	3.15	2.82	2.65	3.00
Meeting and talking with other fishermen	2.29	2.29	2.22	2.57	2.35
Fishing close to home	2.44	2.39	2.51	2.24	2.22

[a]Low average scores on the attitudinal statement.

Table V contains a set of statements that relate to the catching of fish and have been referred to as the "catch attitudes." Differences in factor groups become apparent in this set of statements and the two following sets. The preoccupation of the trophy group with size of fish is evident[12] and appears to overshadow both the number of fish caught, so long as some fish are

Table V. Aspects of fishing with significant variation in importance ranking by NRS license factor groups, 1975

Attitude Statements ("Catch" Attitudes)	Trophy Group	Wild Fish Group	Yield Group	General Recreation Group	Solitude Group
Catching large fish	4.30	2.90	2.77	2.69	2.75
Catching native or wild fish	3.04	4.61	2.70	2.55	3.14
Chance to catch large fish	4.49	3.02	3.10	2.69	3.06
Catching your limit	2.53	2.20	3.29	2.23	2.17
Catching some fish	3.63	3.29	4.17	3.27	3.58

caught, and the type of fish caught, i.e., wild or hatchery-raised. With exception of the trophy group, catching large fish and even the chance to catch large fish do not appear to be of much importance to the other four factor groups. The yield factor group is a near opposite of the trophy group as the scores for the yield group indicate concern for numbers of fish caught and little concern for either the size or kind of fish caught.

The general recreation group is quite passive about the whole business of numbers, size and kind, although fishermen in this group attach moderate importance to catching some fish. The other two factor groups tend to have middle-of-the-road views on the catch attitudes. The wild fish factor group attaches high importance to catching wild or native fish, as would be expected.[13]

The set of statements in Table VI are referred to as "site attitudes" as they all relate to conditions or characteristics of the fishing site. The fish orientation of the trophy and yield groups is confirmed in Table VI:

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[12] There will be an obvious high correlation between the factor groups and the scores on those attitudinal statements that clustered together to determine the group.

[13] The frame of reference of respondents on this statement is uncertain. It is not known whether respondents intended to indicate their preference and, consequently, their ability to distinguish between hatchery-raised and natural spawned fish or whether they were perhaps indicating a preference for fish caught in what the respondent conceived to be a wild or natural setting. The fishery biologists we contacted seriously questioned the ability of the respondents as well as their own ability to generally distinguish between "plants" and "wild" fish.

both factor groups ranked the site attitudes relatively low except for the statement "fishing water surrounded by pleasant scenery," which was of moderate importance to both groups. The wild fish factor group had somewhat similar site preferences to those of the trophy and yield groups. However, this group felt considerably stronger about the importance of pleasant scenery. Moreover, they considered the need for a family-type area or a nice campground to be less important to their outing than did any of the other groups.

Table VI. Aspects of fishing with significant variation in importance ranking by NRS license factor groups, 1975

Attitude Statements ("Site" Attitudes)	Trophy Group	Wild Fish Group	Yield Group	General Recreation Group	Solitude Group
Fishing at family-type areas	2.42	2.25	2.56	3.58	2.28
Fishing water surrounded by pleasant scenery	3.17	3.71	3.10	3.64	3.69
Fishing wilderness-type areas	2.47	2.92	2.38	2.19	3.69
Fishing near nice campgrounds	2.39	2.17	2.54	3.38	2.23

The nature of the general recreation and solitude groups become more evident in this set of statements. While both groups consider site conditions or characteristics to be relatively important, they emphasize different aspects. The general recreation group scored high on the "family areas," "pleasant scenery" and "nice campgrounds" statements. The concern of this group appears to focus on access, convenience and facilities. The solitude group, in reverse order, will apparently forego these concerns in favor of fishing in areas with high scenic value or in wilderness-type areas.

The last set of statements relate to "experience attitudes," Table VII. It is with this set of statements that the preferences of the solitude and wild fish factor groups are most clearly manifest. The average factor scores for the solitude group were the highest of any factor group on four of the five statements included in this set. The wild fish group had the second highest scores on the same four statements ranked high by the solitude group. A review of these four statements suggests a strong escapism, isolation, nature orientation toward fishing on the part of these two groups. The statement that was dropped (i.e., had neither the highest nor second highest score) by the solitude and wild fish groups was "getting out with family and friends."

In fact, these two groups had the lowest scores on this statement of the five factor groups; which is consistent with their general escapist orientation.

Table VII. Aspects of fishing with significant variation in importance ranking by NRS license factor groups, 1975

Attitude Statements ("Experience" Attitudes)	Trophy Group	Wild Fish Group	Yield Group	General Recreation Group	Solitude Group
Getting away from people	3.52	3.87	3.60	3.32	4.54
Seeing few other fishermen	2.87	3.07	2.99	2.53	4.10
Seeing wildlife	3.56	3.79	3.33	3.38	3.86
Getting out with family and friends	3.79	3.44	4.04	4.29	3.69
Getting physical exercise	3.21	3.51	3.22	3.51	3.73

The general recreation group attaches high importance to getting out with family and friends. The orientation of the general recreation group to a "sociable" experience was indicated also in the site attitudes where this group recorded the highest scores on the "fishing at family-type areas" and "fishing near nice campgrounds."

The preceding discussion suggests some generalizations that have management implications.

Generalization 1

The trophy and yield factor groups display considerable comparability in their rankings of the various attitudinal statements. While the trophy group emphasized size and the yield group emphasized numbers, the end product of their fishing experiences appeared to be fish. They had low scores on both the site and experience sets of attitudes. Neither group appeared to be overly concerned with the scenery of an area, the number of other fishermen or whether they fished near family-type areas that had nice campgrounds. In short, the trophy and yield groups appear to be the least demanding of the five factor groups in terms of seeking areas to fish where certain site attractions are available or where the fishing experience can occur under certain conditions.

The attitudinal profiles for these two groups suggest that waters lacking in scenic quality and/or quality development could be managed as a trophy water or as a high yield (put-and-take) fishery and, if the management programs were successful, provide a satisfactory fishing experience to fishermen in the trophy or yield groups.

Generalization 2

There was a large block of fishermen for which scenic quality and general development level of the area was of primary interest. The focus of this group, the general recreation factor group, was apparently directed toward fishing areas with attractive campgrounds and to areas that offered family-type recreation opportunities other than fishing. The most important aspect of fishing for this factor group may have been that it served as a rallying cause or justification to get family and friends committed to an outing. It is likely that the general recreation factor group also included those marginal fishermen who fished only because the occasion seemed to require it or because the outing presented an outstanding opportunity to fish.

It would appear that this group of fishermen could be managed into or from an area by controlling the development level of campgrounds and other facilities that affect the overall recreation attractiveness of an area. Poor access and lack of developed facilities would be reason for this group to shun an area. Ease of access, scenic attractiveness and recreational diversity are factors that would pull the general recreation factor group to an area.

Generalization 3

The solitude and wild fish factor groups had similar ranking patterns across most of the attitudinal statements. In many respects, the ranking patterns indicate these two groups may be two components of a larger group. The reason for the separation or distinction between the two components is the degree of importance the one component, the wild fish factor group, attaches to being able to catch wild or native fish. Otherwise, both groups indicated a strong preference for high quality scenic areas, the presence of wildlife, and relative freedom from other fishermen, perhaps including their own families.

Fishermen in these two groups are the most resource-demanding of the five groups. Considering the limited number of available fishing areas that would satisfy fishermen from these two groups, they are likely to be the most difficult and costly factor groups to satisfy--costly in the sense that the resource base per fisherman is high where waters in a high quality natural setting are managed to keep fishing pressure low. If the fishery management objective is directed toward numbers rather than type of fishermen, a management program of easy access and nice facility development will undoubtedly encourage maximum use of the land as well as the water in high quality scenic areas. On the other hand, if fishery management is sensitive to the preferences and requirements of the various types (factor groups) of fishermen, an argument can be made to manage some, if not all, fisheries located in high quality natural areas in accordance with the general desires of fishermen in the solitude and wild fish factor groups.

This is not to imply that these two fishermen groups claim some type of elitist consideration that entitles them to a first right claim on all fishery resources. Neither the analysis conducted in the course of the study nor our interpretation of the results suggests that any one group or, for that matter, any individual fisherman has any greater claim on a fishery resource than does any other factor group or individual. The basis of our argument to favor the solitude and wild fish groups in the management of these areas is one of relative supply. The relative number of waters that can be managed for the benefit of the solitude and wild fish factor groups is generally more limited than the number of waters that can be managed to accommodate the preferences of the other three factor groups.

Why the concern with fisherman types? The concern can be expressed as a question of the effectiveness of fishery management programs in providing the public with the services or products fishery management agencies are mandated to provide. Can the fisheries managment program be changed or re-emphasized in some manner to increase total public satisfaction? More specifically, are the resources controlled by the fishery management agency committed to programs that will provide a mix of fishing experiences that is roughly proportional to the mix of fishing experiences desired? Our analysis of the attitudinal data suggest that since fishermen may be more concerned with fishing conditions than they are with kind and size of fish, a management program that includes all waters under a common management objective, particularly with regard to control of the fishing experience, could produce a lower total satisfaction among fishermen than a descretionary management program designed to control the type of fishing experience.

The key to discretionary management programs is, of course, knowledge of the fisherman and the fishing experience he desires. While our analysis, as have the analyses of others, indicates there are differences in the experience sought by the different fishermen groups and these differences can be translated into management alternatives, the strength or importance of underlying differences among the fishermen groups has not been demonstrated. The potential success of discretionary management programs would depend on fisherman reaction to the different plans. If a water managed under a trophy program objective was not successful in attracting trophy fishermen or if a water managed to suit the expressed preferences of the solitude and wild fish factor groups was not successful in attracting these types of fishermen, the value of developing discretionary management programs would be questionable. In other words, before discretionary management programs that differentiate among the fishing experiences desired by different fishermen groups are initiated, tests need to be conducted to see if fishermen behavior is indeed subject to differentiation.

The final evaluation of fishery management programs designed to discriminate among fishermen groups is not just a question of whether the behavior of fishermen will be responsive to different fishery management objectives and programs, but whether the results obtained from such programs justify the cost of implementing them. Ultimately, this evaluation will have to recognize that the value of fishing is not the same for all factor groups and that economic efficiency in the allocation of fishery resources among fishermen types cannot be achieved through resource allocations that are made in proportion to the relative number of fishermen in each factor group. While our analysis of fisherman attitudes and preferences cannot be used to determine whether the different fishermen groups attach different values to fishing and, if they do, to what extent the values differ, the analysis does suggest that there are differences in the value attributed to fishing. For example, there are indications that fishermen in the general recreation factor group are rather casual about fishing. If so, economic efficiency considerations would require that the general recreation factor group fisherman be assigned lower weights in the allocation formula than fishermen in the other factor groups. There could be situations where no resources would be assigned to this factor group or to any other factor group where the relative value of fishing was low in comparison to other fishermen groups. It is conceivable that the value of the product derived from fishing for a particular group of fishermen was so low that the product could be supplied more economically through some other recreation activity.

The concept of economic efficiency is equally applicable to all considerations of instream flow requirements for recreation. Before the allocation of streamflows for recreation can procede within an economic efficiency framework, the product and the <u>value</u> of the product of the various instream recreation activities will have to be determined. Where the product and the value of the product of competing streamflow uses are known, the case for instream flow allocations to recreational uses appears weak and ambiguous when the products and relative values of recreation are only vaguely perceived.

In summary, it does not seem presumptuous to conclude with a recommendation that the focus of research endeavors into instream flow problems should be directed toward an identification of the products that will be generated through modification of present streamflow regimes. Furthermore, there is a need of economic evaluation so that recommended streamflow modifications can be effectively brought into the arena of public discussion and decision-making.

IRRIGATION: THE COMPETITION WITH INSTREAM USES OF WATER*

Norman K. Whittlesey
Agricultural Economics
Washington State University
Pullman, WA 99163

ABSTRACT

Water supply in the Snake and Columbia Rivers is no longer sufficiently abundant to meet all instream and diversion uses without conflict. This paper addresses the issue of competition between irrigation development and the instream uses of water. Particular attention is given to the energy costs imposed by irrigation through lost hydropower production and replacement costs of energy used to pump irrigation water. It is shown that annual energy costs of more than $100 per acre can be incurred in some irrigation developments.

INTRODUCTION

As water flows through different farms, cities, counties, and states, many different people, industries and governments claim the right to use the water. Some will seek to use water as an economical means of waste disposal. Others seek to use water as a means of navigation, electric generation, recreation, or simply a source of spiritual solitude and well-being. Agricultural, municipal and industrial uses usually require diverting the water from its natural source in order to be used. Obviously, these varied and disparate uses are often in conflict. Moreover, the value of some uses is easily measured in economic terms while others, though important to some people, are more difficult to evaluate.

Water uses can be classified in several ways. One important classification is the distinction between consumptive and nonconsumptive uses. Consumptive uses generally require the water to be transported from its natural location for employment and consumption in another place. Power production, navigation, recreation, fisheries, and waste dissemination are largely instream uses that do not require relocation of the water. These uses are generally classified as nonconsumptive. This paper is primarily concerned with the competition between the known instream uses of water and the consumptive

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diversion uses. When water is removed from a river for consumption by agriculture or other activities, it is no longer available for the established instream uses which may have considerable value to various segments of society.

TRADE-OFFS

Water law, the PNW states, was designed in a period when water seemed to be sufficiently abundant for all uses without serious social conflict. This concept of relative abundance has prevailed up to the present and has resulted in a general policy of encouraging water use expansion. We must begin this discussion with a clear understanding that water in the Columbia Basin is a scarce commodity. Water not used for agriculture or industry will not "just go to waste." In the future, all stream flows in the Columbia and Snake Rivers will be utilized for instream uses such as hydropower, waste dilution, fish passage, recreation, and navigation. These uses, though nonconsumptive, create a value for the instream presence of the water.

To encourage irrigation development under these conditions requires an explicit decision to divert water from one economic use to another. In this case, the public is foregoing some potential energy value and value of other instream uses for every unit of water diverted. There is no simple market mechanism available to establish use values for fish, recreation, or navigation, but they do exist, and water allocation policy should give a recognition to their existence. When a water right is given to an individual for irrigation, society is effectively transferring a good from the public to the private domain. The entire value of that resource can be captured in the land owned by the individual for eventual sale or transfer to heirs.

The diversion of an acre-foot of water from the Columbia River, for example, eliminates its potential for creating electricity downstream. The cost of generating the same amount of electricity by the next most efficient means, say a thermal power plant, is the "opportunity cost" of that unit of water in the instream use. If other instream uses are also affected, their replacement value must be added to the hydropower value to calculate the full opportunity cost of the water. Water allocations change through the granting of new water rights for irrigation or industrial activity; some or all segments of society actually incur the cost of water in its old uses through required new investments in electrical generating plants, sewage treatment plants, and other means of transportation and recreation. Thus, the opportunity cost of water is the measure of the income transfer from one segment of society to another that is initiated by granting the new water right.

WATER VALUE

In other segments of our market economy, a product or resource is exchanged when the value of the good to the buyer exceeds its value to the seller. If it can be shown that water in its instream uses does have a real present value to some or all members of the general public, it could then be argued that, before the water can be diverted to another use, the public should be compensated for the real monetary value of the water in present uses. Even if the compensation does not occur, we should be sure that the value of water in its diversion use exceeds its collective value for instream uses.

The most obvious public loss incurred when diverting water from the Columbia or Snake Rivers is that of hydropower production. In the future all potential normal stream flows in these rivers can be used for the production of hydropower. Thus, any consumptive diversion will reduce that possible downstream use. Society must then produce this lost power by the next most efficient means, most likely thermal power plants. This is a real, measurable, and significant societal cost.

The estimated electrical power loss from diversion of an acre-foot of water at various points along the Columbia River is shown in table 1. Obviously, the further upstream the diversion, the greater is the loss in potential power. Diversions for the Columbia Basin Project or the porposed East High Project would eliminate the production of 847 kwh for each acre-foot of water diverted while using an additional 698 kwh to pump the water. Diversions for irrigation further downstream in the Horse Heaven Hills would reduce the power development potential of water by 222 kwh per acre-foot of water while using an additional 735 kwh. These quantities must by added to the supply of electricity through investments in other energy producing activities as irrigation development proceeds. Alternatively, consumption of electricity can be reduced by rationing or charging higher prices for electricity. In any case, there is a loss to the present energy consumer.

Table 1 shows the comparative value of electrical power lost to water diversion in various areas of the state. These calculations are based upon a

Table 1. Estimated Societal Cost of Lost Energy Due to Water Diversion for Specific Areas of the State

Project	Divert from	Energy		Value of Energy			Total Value Per Acre[c/]
		Lost	Used	Lost[a/]	Used[b/]	Total	
		- -KWH/AF- -		- - - - -$/AF- - - - -			$/Acre
Eureka Flat[d/]	Ice Harbor	463	750	9.26	12.75	22.01	77.04
Walla Walla	Snake River below Ice Harbor	289	149	5.78	2.53	8.31	29.10
East High Project[e/]	Grand Coulee	847	698	16.94	11.87	28.81	100.82
Horse Heaven Hills[f/]	John Day	222	735	4.44	12.50	16.94	59.27

a/ Energy cost calculated at 20 mills/KWH.

b/ Energy value calculated at 17 mills/KWH.

c/ This calculation is based on an assumed diversion of 3.5 acre-feet of water per acre irrigated. These costs would be incurred annually for each acre irrigated.

d/ Total area.

e/ Total project.

f/ Blocks 3 and 4.

value of electricity of 20 mills per kwh, the estimated cost of replacing the lost energy by nuclear power production. It is calculated that agriculture is paying 3 mills per kwh for energy used to pump water, leaving 17 mills of the replacement cost to be paid by other electricity users.[1/] The loss of power that could have been developed is not compensated for in any manner and is totally lost, and thus must be charged as a cost of diversion.

The cost of replacing lost energy due to diversions for irrigation in the Horse Heaven Hills is shown to be $4.44 per acre-foot of water. For irrigating the East High Project the lost energy value of water is $16.94 per acre-foot. Table 1 shows the full energy cost of water for irrigating the Horse Heaven Hills to be $16.94 per acre-foot, and for irrigating the East High Project, it is $28.81 per acre-foot. These latter figures include the additional cost of replacing the energy used to divert the water. The former lower figures are the actual instream energy values of water. As representatives of society, we should be sure that the value of water in its diversion uses (agriculture) exceeds its value of instream uses prior to granting a water right for diversion.

The total energy costs of irrigation diversion quoted above include the societal cost of replacing the energy used to divert the water, plus the lost hydropower potential of the water. Agriculture presently pays about 3 mills per kwh for energy that costs at least 20 mills to replace. The total energy costs are a part of the real societal cost of development and should be weighed when considering the merits of irrigation development. However, the societal costs of energy used to divert water result from the manner in which energy is priced to the public rather than the loss of instream water use. Energy is priced following average cost rather than marginal cost pricing techniques. This difference is not unlike the societal cost that is incurred when someone buys a new electric golf cart or microwave oven and increases his consumption of electricity. We allow that person to use more elctricity at its average cost to society while knowing that it must be replaced or added to the system at a much higher (marginal) cost.

Assuming that 3.5 acre-feet of water are diverted for each acre of land, the value of energy <u>lost</u> per acre irrigated in the Horse Heaven Hills is $15.54 and for the East High Project $59.29. The additional loss to society due to the manner in which energy is priced is $43.73 per acre in the Horse Heaven Hills and $41.53 in the East High Project. The total of these figures,

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[1/] Agriculture pays more than 3 mills per kwh for electricity, but the difference is payment for electricity marketing and distribution and does not contribute toward energy production.

more than $59 in the Horse Heaven Hills and $100 in the East High Project, is the annual energy cost that would be incurred by the general public for irrigation in these two areas. These factors should be weighed at the time we are making public decisions regarding irrigation development in the Pacific Northwest.

The current investment cost per kwh required for construction of nuclear power plants is estimated to be $1280 per kw capacity. Thus to replace the electricity used and lost in the East High Project would require an investment in a nuclear power plant of $1890 per irrigated acre or $1170 per irrigated acre in the Horse Heaven Hills. To be fair, since agriculture would use this power generating facility for only six months of the year, about one-third of the total investment cost could be charged to other societal uses.

COST DISTRIBUTION

In general, the cost of nuclear energy generation to replace hydro losses and meet expanded energy loads is averaged in with all other costs of the federal system and passed along to consumers in the form of rate increases. In 1972, energy sales from BPA were distributed 56% to Washington, 28% to Oregon, 6% to Montana, 10% to Idaho, and less than 1% to California. Assuming this pattern holds in the future, we could estimate that 56% of the cost due to reduced hydro electric output would fall upon consumers in Washington. Initially, this might seem advantageous because Washington can pass along 44% of the cost of its actions to other states. However, it is a two edged sword. Idaho can, and probably will, increase diversions from the Snake River. Idaho consumers would bear 10% of the cost for lost hydropower and Washington potentially would bear 56%. An acre-foot of water diverted in southern Idaho will have a remaining hydropower potential of about 1,200 kwh. Using a replacement value of 20 mills per kwh, the value of this water would be about $24 per acre foot. This calculation includes nothing for the cost of replacing the energy used to divert the water. We have seen that in some situations the societal cost due to energy pricing can be equal to that of the lost power. About 90% of this energy cost would fall on people outside the state of Idaho. This is a strong argument for quickly arriving at a Columbia-Snake River compact for allocation of water among its alternative uses.

It is impossible to predict how the cost burdens of energy development might be shared in the future. Given a specific proposal, the resulting distribution of cost burden might be determined. But, it does seem unlikely that the beneficiaries of diversion will be required to accept the full burden of the energy costs, and a share of these costs will probably be imposed on electrical energy consumers generally in the Northwest.

At present, more than four million acres of additional land are planned for development in the Pacific Northwest states. Full development will not only impose significant energy costs on society but will most likely violate other instream uses of water as well. Each of these potential costs or conflicts should be carefully identified and properly weighed in all public or private irrigation developments. To do otherwise may result in gross misallocations of water throughout the future of this region.

This paper has shown that water does have real and significant instream value. We should be careful to assure ourselves and the public that changes in present resource allocations will lead to an improvement in economic or social welfare. This cannot be assured unless the value of water for diversion uses clearly exceed the instream value of water.

MANAGEMENT OF RIVER SYSTEMS

D. B. Simons
Associate Dean for Research and Professor of
Civil Engineering, Engineering Research Center
Colorado State University
Fort Collins, CO 80523

ABSTRACT

The optimum management of river systems requires utilization of the knowledge and cooperation of all pertinent disciplines. It is no longer acceptable to treat river problems from the viewpoint of a single discipline. This paper provides basic information on river form and river classification, the mechanics of flow in alluvial channels, concepts of sediment transport in alluvial channels, the response of rivers and the physical and mathematical modeling of river systems as required by the various disciplines to understand the short-term and long-term impacts of climatological changes and works of man on parts of rivers and on river systems. Methods of utilizing the concepts presented herein to predict the qualitative response of rivers to development are illustrated and methods of conducting more detailed quantitative analysis are suggested.

INTRODUCTION

The management of river systems is of great concern and of vital interest to all of us. In order to optimize utilization of our water resources it is essential to understand the basic concepts that explain watershed and river behavior and their responses to natural changes and those changes imposed by man's development of these systems. Perhaps with this approach improved beneficial uses can be more accurately identified and implemented. Hence, the purpose of this presentation is to organize and present the basic geomorphic, hydrologic and hydraulic concepts essential to the qualitative determination of river and river system response to various development and management schemes.

STREAM FORM AND CLASSIFICATIONS

Rivers can be classified broadly in terms of channel pattern. Patterns include straight, meandering braided, or some combination of these (Fig. 1).

There are subclassifications within the major types of meandering, straight, and braided channels that are of use to the geomorphologist and engineer. For more detail on subclassification systems refer to Rundquist (1975).

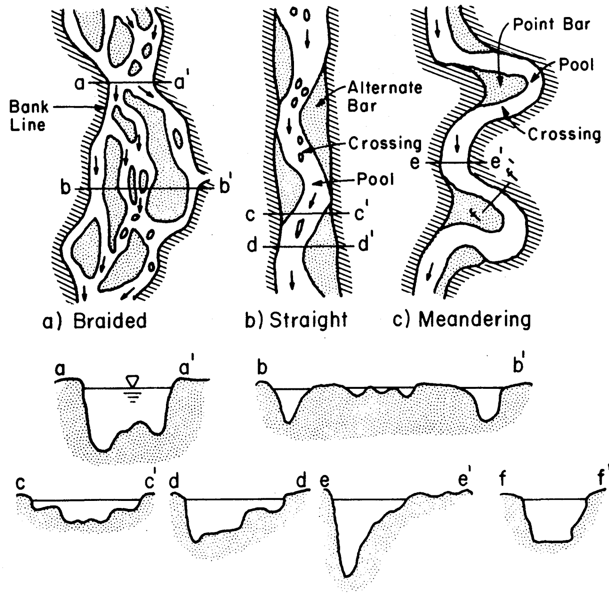


Fig. 1. River Channel Patterns, Simons et al. (1975)

Reaches of a river that are relatively straight over a long distance are generally unstable, as are divided flow reaches, and those in which bends are migrating rapidly. Long straight reaches can be created by natural or man-made cutoff of meander loops where long reaches of sinuous meandering channels with relatively flat slopes are converted to shorter reaches with much steeper slopes. Straight reaches can also be man-induced by placing of contraction works such as dikes and revetment to reduce or control sinuosity.

The Braided Channel

A braided river is relatively wide with poorly defined unstable banks, and is characterized by a steep, shallow water course with multiple channel divisions around alluvial islands. Braiding is one of many patterns which can maintain quasiequilibrium among the variables of discharge, sediment load, and transporting ability. Lane (1957) concluded that, generally, the two primary causes that may be responsible for the braided condition are: (1) the stream may be supplied with more sediment than it can carry resulting in deposition of part of the load, and (2) steep slopes, which produce a wide shallow channel where bars and islands form readily.

Either of these factors alone, or both in concert, could be responsible for a braided pattern. If the channel is overloaded with sediment, deposition occurs, the bed aggrades, and the slope of the channel increases in an effort to maintain a graded condition. As the channel steepens, the velocity increases, multiple channels develop and cause the overall channel system to widen. The multiple channels, which form when bars of sediment accumulate within the main channel, are generally unstable and change position with both time and stage.

Another cause of braiding is easily eroded banks. If the banks are easily eroded, the stream widens at high flow and at low flow bars form which become stabilized, forming islands. In general, then, a braided channel has a steep slope, a large bed-material load in comparison with its suspended load, and relatively small amounts of silts and clay in the bed and banks. The braided stream is difficult to work with in that it is unstable, changes its alignment rapidly, carries large quantities of sediment, is very wide and shallow even at flood flow and is in general unpredictable.

The Meandering Channel

A meandering channel is one that consists of alternating bends, giving and S-shape appearance to the plan view of the river. More precisely, Lane (1957) concluded that a meandering stream is one whose channel alignment consists principally of pronounced bends, the shapes of which have not been determined predominantly by the varying nature of the terrain through which the channel passes. The meandering river consists of a series of deep pools in the bends and shallow crossings in the short straight reach connecting the bends. The thalweg flows from a pool through a crossing to the next pool forming the typical S-curve of a single meander loop.

As shown schematically in Fig. 1, the pools tend to be somewhat triangular in section with point bars located on the inside of the bend. In the crossing the channel tends to be more rectangular, widths are greater and depths are relatively shallow. At low flows the local slope is steeper and velocities are larger in the crossing than in the pool. At low stages the thalweg is located very close to the outside of the bend. At higher stages, the thalweg tends to straighten. More specifically, the thalweg moves away from the outside of the bend encroaching on the point bar to some degree. In the extreme case, the shifting of the current causes chute channels to develop across the point bar at high stages. Note that in the crossings the channel is shallow compared to pools and the banks may be more subject to erosion.

The Meandering Process

Alluvial channels of all types deviate from a straight alignment. The thalweg oscillates transversely and initiates the formation of bends. In general, the river engineer concerned with channel stabilization should not attempt to develop straight channels. In a straight channel the alternate bars and the thalweg (the line of greatest depths along the channel) change continuously; thus the current is not uniformly distributed through the cross section but is deflected toward one bank and then the other. Sloughing of the banks, nonuniform deposition of bed load by debris such as trees, and the Coriolis force have been cited as causes for meandering of streams. When the current is directed toward a bank, the bank is eroded in the area of impingement and the current is deflected away and may impinge upon the opposite bank further downstream. The angle of deflection of the thalweg is affected by the curvature formed in the eroding bank and the lateral depth of erosion.

As a meandering river system moves laterally and longitudinally, the meander loops move at an unequal rate because of the unequal erodibility of the banks. This causes a tip or bulb to form and ultimately this tip or bulb is cut off. After the cutoff has formed, a new bend may slowly develop. Its geometry depends upon the local slope, the bank material, and the geometry of the adjacent bends. Over time the local steep slope caused by the cutoff is distributed both upstream and downstream. Years may be required before a configuration characteristic of average conditions in the river is attained.

When a cutoff occurs, an oxbow lake is formed. Oxbow lakes may persist for long periods of time before filling. Usually the upstream end of the lake fills quickly to bank height. Overflow during floods carries fine materials into the oxbow lake area. The lower end of the oxbow remains open and the drainage and overland flow entering the system can flow out from the lower end. The oxbow gradually fills with fine silts and clays. Fine material that ultimately fills the bendway is plastic and cohesive. As the river channel meanders it encounters old bendways filled with cohesive materials (referred to as clay plugs). These plugs are sufficiently resistant to erosion and serve as essentially semipermanent geologic controls.

The variability of bank materials and the fact that the river encounters such features as clay plugs cause a wide variety of river forms coincident with a meandering river. The meander belt formed by a meandering river is often 15 to 20 times the channel width.

The Continuum of Channel Patterns

Because of the physical characteristics of straight, braided, and meandering streams, all natural channel patterns intergrade. Although braiding and meandering patterns are strikingly different, they actually represent extremes in a continuum of channel patterns. On the assumption that the pattern of a stream is determined by the interaction of numerous variables whose range in nature is continuous, one should not be surprised at the existence of a river that may exhibit both braiding and meandering, and alteration of the controlling parameters in a reach can change the character of a given stream from meandering to braided or vice versa.

A number of studies have quantified this concept of a continuum of channel patterns. Khan (1971) related sinuosity, slope, and channel pattern (Fig. 2). Any natural or artificial change which alters channel slope such as the cutoff of a meander loop, can result in modifications to the existing river pattern. A cutoff in a meandering channel shortens channel length, increases slope, and tends to move the plotting position of the river to the right on Fig. 2. This indicates a tendency to evolve from a relatively tranquil, easy to control meandering pattern to a braided pattern that varies rapidly with time, has high velocities, is subdivided by sandbars, and carries relatively large quantities of sediment. Conversely, a slight

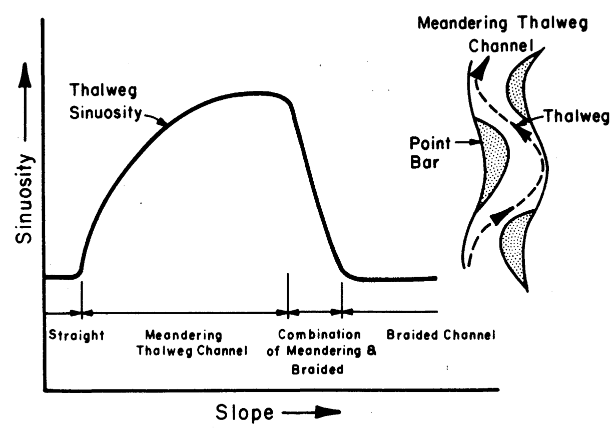


Fig. 2. Sinuosity vs. Slope with Constant Discharge. (Channel patterns are illustrated in Fig. 1.)

decrease in slope could change an unstable braided river into a more stable meandering pattern.

Lane (1957) investigated the relationship among slope, discharge and channel pattern in meandering and braided streams, and observed that an equation of the form

$$SQ^{1/4} = K \tag{1}$$

fits a large amount of data from meandering sand streams. Here S is the channel slope, Q is the water discharge, and K is a constant. Figure 3 summarizes Lane's results. If a river is meandering, but with a discharge and slope that borders on transitional, a relatively small increase in channel slope could initiate a tendency toward a transitional or braided character.

The Longitudinal Profile

The longitudinal profile of a stream shows its slope, or gradient. It is a visual representation of the ratio of the fall of a stream to its length over a given reach. Since a river channel or river system is generally steepest in its upper regions, most river profiles are concave upward. As with other channel characteristics, shape of the profile is undoubtedly the result of a number of interdependent factors. It represents a balance between the transport capacity of the stream and the size and quantity of the sediment load supplied.

Shulits (1941) and others have provided an equation describing the concave horizontal profile of a channel in terms of distance along the stream

$$S_x = S_o e^{-\alpha x} \tag{2}$$

where S_x = the slope at any station a distance x downstream of a reference station; S_o = the slope at the reference station; α = a coefficient of slope reduction.

Similarly, grain size of the bed material decreases in a downstream direction, a fact confirmed by field observations on many rivers (Fig. 4). Transport processes alter the size of sediment particles by abrasion and hydraulic sorting. Abrasion is the reduction in size of particles by mechanical action such as grinding, impact, and rubbing, while hydraulic sorting is the result of differential transport of particles of different sizes. For sedimentary particles of similar shape, roughness, and specific gravity, the end result of these processes is the observed reduction of bed material size along the direction of transport. The change in particle size with distance downstream can be expressed as

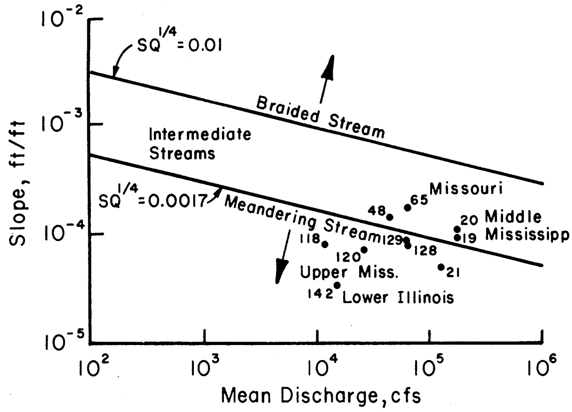


Fig. 3. Slope-discharge Relation for Braiding or Meandering in Sand Bed Streams (Lane, 1957)

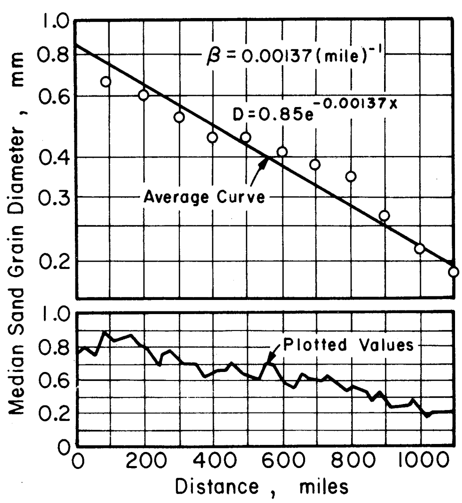


Fig. 4. Size Distribution of Bed Material with Distance, x

$$D_{50x} = D_{50o}{}^{-\beta x} \quad (3)$$

where D_{50x} = median size of bed material at distance x downstream of a reference station; D_{50o} = median size of bed material at the reference station; β = a wear or sorting coefficient. This relationship, in general, plots as a straight line on semilogarithmic coordinates, see Fig. 4. This trend is found in channels both large and small.

The longitudinal profile of an alluvial river is not static. It adjusts to continually changed input conditions of water and sediment discharge. Adjustments to input conditions change the channel geometry, roughness, and other parameters including channel gradient. A simplified analysis of this response results if it is assumed that a stream adjusts only its gradient.

If a river is unable to move all of its load downstream of a given point on the profile, it will build up the channel bed, causing an increased slope below the point and thus an increased ability to transport. At the same time deposition results in a decrease in gradient and transport capacity above the point, and a wave of aggradation moves upstream.

FLOW IN ALLUVIAL CHANNELS

The interaction between the flow of the water-sediment mixture and the river bed creates different bed configurations which change the resistance to flow and rate of sediment transport. The gross measures of channel flow such as the flow depth, river stage, bed elevation and flow velocity change with different bed configurations. In the extreme case, the change in bed configuration can cause a three-fold change in resistance to flow and a 10- to 15-fold change in concentration of bed-material transport. For a given discharge and channel width, a three-fold increase in Manning's n results in a doubling of the flow depth.

Variables Affecting Alluvial Channels

Because of the large number of interrelated variables that can respond simultaneously to natural or imposed changes in a river system, river response to both natural and man-imposed forces is complex and varied in nature but predictable.

Simons and Richardson (1966) have given a detailed analysis of the variables affecting alluvial channel geometry and bed roughness. They conclude that the nature of these variables is such that, unlike rigid boundary hydraulics problems, it is not possible to isolate and study the role of an individual variable. For example if one attempts to evaluate the effect of increasing channel depth on average velocity, additional related variables respond to the changing depth. Thus, not only will velocity respond to a change in depth, but also the form of bed roughness, the shape of the cross section, the quantity of sediment discharge, and the position and shape of alternate, middle, and point bars can be expected to change.

The list of variables that influence alluvial channel flow should include velocity, depth, slope of energy grade line, density of water-sediment mixture, apparent viscosity of water-sediment mixture, gravitational constant, representative fall diameter of the bed material, gradation of bed material, density of sediment, shape factor of the particles, shape factor of the reach of the stream, shape factor of the cross section of the stream, seepage force in the bed of the stream, concentration of bed-material discharge, fine material concentration, and particle terminal fall velocity.

Applying techniques of dimensional analysis to this list of variables verifies the importance of the Froude number $(V\sqrt{gy})$, the Reynolds number $(Vy\rho/\mu)$ and a relative roughness parameter (D/y).

Bed Forms and Resistance to Flow

The bed of an alluvial river is seldom a smooth regular boundary, but is characterized instead by forms that vary in size, shape, and location under the influence of changes in flow, temperature, sediment load, size of bed material and other variables. These bed forms cause a major part of the resistance to flow exhibited by an alluvial channel, and exert a significant influence on flow parameters such as depth, velocity, and sediment transport.

Bed Configuration without Sediment Movement

If the bed material of a stream moves at one discharge but not at a smaller discharge, the bed configuration at the smaller discharge will be a remnant of the bed configuration formed when sediment was moving.

In general, Shields' relation, Fig. 5, is adequate to define beginning of motion of bed material. After the beginning of motion, the bed will become rippled for sand material smaller than 0.6 mm, and dunes will develop for material no coarser than 0.6 mm. Resistance to flow is small for a plane bed without sediment movement and it is due solely to the sand grain roughness. Values of Manning's n range from 0.012 to 0.016 depending on the size of the bed material.

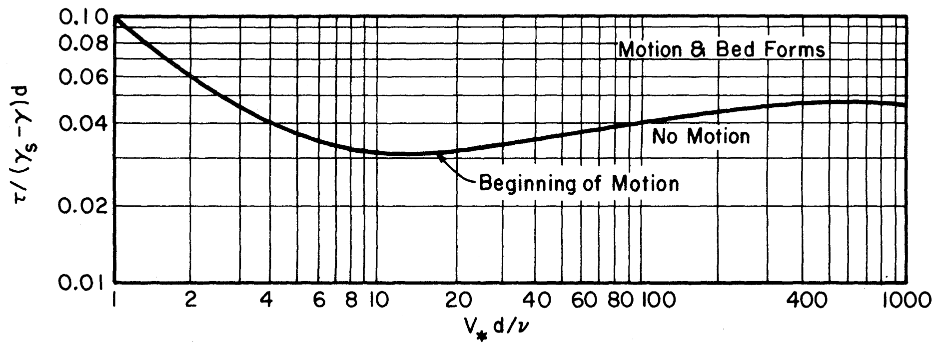


Fig. 5. Shields Relation for Beginning of Motion

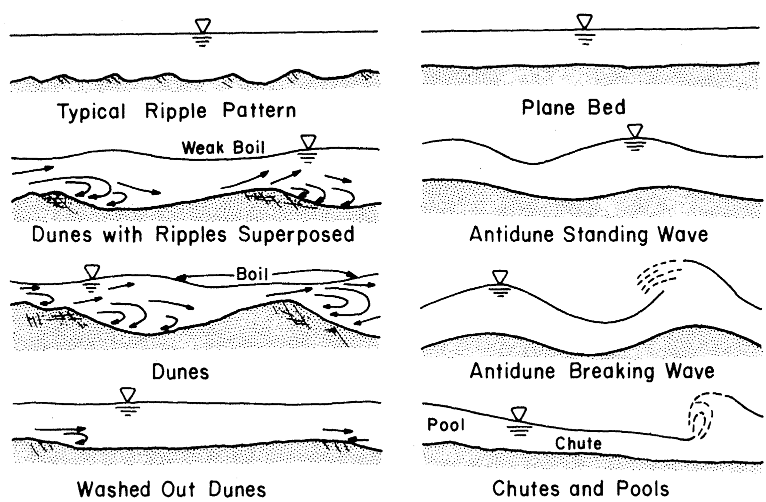


Fig. 6. Typical Bed Forms in Sand-bed Channels
(Simons and Richardson, 1966)

Bed Configuration with Sediment Movement

Profiles of typical bed forms and their relation to the water surface are shown in Fig. 6. Using these bed forms as a basic criteria, flow in alluvial channels is divided into two regimes of flow separated by a transition zone. These two flow regimes are characterized by similarities in the shape of the bed form, mode of sediment transport, process of energy dissipation, and phase relation between the bed and water surface. These two regimes and their associated bed forms are:

1. Lower Flow Regime--small stream power
   a. Ripples
   b. Ripples superposed on dunes
   c. Dunes
2. Transition Zone
3. Upper Flow Regime--large stream power
   a. Plane bed (with sediment movement)
   b. Antidunes
   c. Chutes and pools

Simons and Richardson (1966) developed a graphical relation among stream power (τV), median fall diameter, and bed form using both flume and stream data. This relation (Fig. 7) gives an indication of the form of bed roughness to be anticipated if the depth, slope, velocity, and fall diameter of the bed material are known. Another useful graphical relation (Fig. 8) shows schematically the effect of bed form on roughness coefficients such as Manning's n. As the bed configuration sequences through lower regime to upper regime Manning's n changes from a typical value of 0.012 to 0.016 for plane bed without sediment motion to values as high as 0.04 for a dune bed. If one increases the stream power, upper regime plane bed conditions will develop that can produce a decrease in roughness to values as small as 0.010 to 0.015.

In a natural stream it is possible to experience a large increase in discharge with little or no change in stage as a result of a change in bed configuration from dunes to plane bed. Figure 9 shows a typical break in the depth-discharge relation resulting from this phenomena. Conversely, several investigators have shown that an increase in depth, with constant slope and bed material, can change a dune bed to plane bed or antidunes, and that a decrease in depth can reverse the process.

Bars in Alluvial Channels

In natural or field-size channels, other bed configurations are also found. These bed configurations are generally called bars and are related to the plan form geometry and the width of the channel.

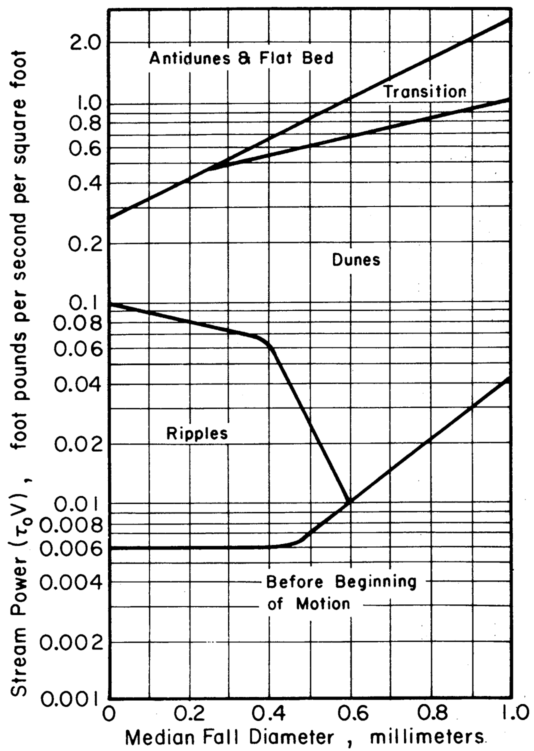


Fig. 7. Relation of Stream Power and Median Fall Diameter to Form of Bed Roughness

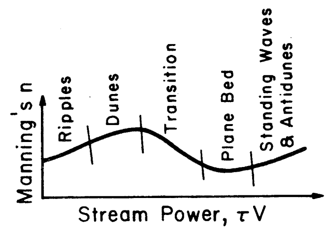


Fig. 8. Resistance to Flow Versus Bed Form

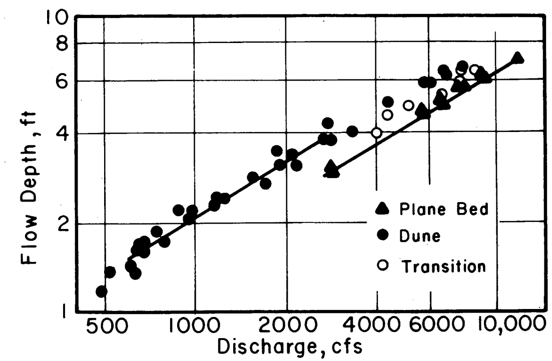


Fig. 9. Relation of Depth to Discharge for Elkhorn River near Waterloo, Nebraska (Simons and Richardson, 1971)

Bars are bed forms having lengths of the same order as the channel width or greater, and heights comparable to the mean depth of the generating flow. Several different types of bars occur. They are classified as:

(1) Point Bars which occur adjacent to the convex bank of channel bends. Point bar shape may vary with changing flow conditions, but point bars do not move relative to the bends.

(2) Alternate Bars which occur in straighter reaches of channels and tend to be distributed periodically along the reach, with consecutive bars on opposite sides of the channel. Their lateral extent is significantly less than the channel width. Alternate bars move slowly downstream.

(3) Transverse Bars (middle bars) which also occur in straight channels. They occupy nearly the full channel width. They occur both as isolated and as periodic forms along a channel, and move slowly downstream.

(4) Tributary Bars which occur immediately downstream from points of lateral inflow into a channel.

In longitudinal section, bars are approximately triangular, with very long gentle upstream slopes and short downstream slopes that are approximately the same as the angle of repose. Bars appear as small barren islands during low flows. Portions of the upstream slopes of bars are often covered with ripples or dunes. These bars significantly affect the development of new flow alignments as well as resistance to flow.

Hydraulic Geometry of Alluvial Channels

Hydraulic geometry is a general term applied to alluvial channels to denote relationships between discharge, Q, and the channel morphology, hydraulics and sediment transport. In self-formed alluvial channels, the morphologic, hydraulic and sedimentation characteristics of the channel are determined by a large variety of factors. In general, these relations apply to channels within a physiographic region and can be derived from data available on gaged rivers. It is understood that hydraulic geometry relations express the integral effect of all the hydrologic, meteorologic, and geologic variables in a drainage basin.

The hydraulic geometry relations of alluvial streams are necessary in river engineering and river modeling. The forerunner of these relations are the regime theory equations of stable alluvial canals. A generalized version of hydraulic geometry relations was developed by Leopold and Maddock (1953) for different regions in the United States and for different types of rivers. In general the hydraulic geometry relations are stated as: $W = a\,Q^b$; $y_o = c\,Q^f$; $V = k\,Q^m$; $Q_T = p\,Q^j$; $S = t\,Q^z$; $n = r\,Q^y$, where W is the channel width, y_o is the channel depth, V is the average velocity of flow, Q_T is the total bed-material load, S is the energy gradient, n is the Manning's roughness coefficient, and Q is the discharge as defined in the following paragraphs. Leopold and Maddock (1953) have shown that in a drainage basin, two types of hydraulic geometry relations can be defined: (1) relating W, y_o, V and Q_T to the variation of discharge at a station, and (2) relating these variables to the discharges of a given frequency of occurrence at various stations in a drainage basin. Because Q_T is not available they used Q_s the suspended load transport rate. The former are called at-station relationships and the latter downstream relationships.

More recently hydraulic geometry relations were theoretically developed at Colorado State University, Simons and Li (1975). These relations are almost identical to those proposed by Leopold and Maddock. The at-station relations derived at Colorado State University are:

$$W \sim Q^{0.26} \tag{4}$$

$$y_o \sim Q^{0.46} \tag{5}$$

$$S \sim Q^{0.00} \tag{6}$$

$$V \sim Q^{0.30} \tag{7}$$

Equation (6) implies that slope is constant at a cross section. This is not quite true. At low flow the effective channel slope is that of the thalweg that flows from pool through crossing to pool. At higher stages the thalweg straightens somewhat shortening the path of travel and increasing the local slope. In the extreme case river slope approaches the valley slope at flood stage. It is during high floods that the flow often cuts across the point bars developing chute channels. This path of travel verifies the shorter path the water takes and that a steeper channel prevails under this condition.

The derived downstream relations for bank-full discharge are:

$$y_b = Q_b^{0.46} \tag{8}$$

$$W_b = Q_b^{0.46} \tag{9}$$

$$S = Q_b^{-0.46} \tag{10}$$

$$V_b = Q_b^{0.08} \tag{11}$$

where the subscript b indicates the bank-full condition.

SEDIMENT TRANSPORT IN ALLUVIAL CHANNELS

The sediment in a river has its origin in the drainage basin. Eroded material is carried into the river and along the river's course by flowing water. The ultimate fate of this material is deposition in the lower reaches of the river, on the river delta, or for the finer material, in the sea. This constant displacement of material implies a slow but continuous change in the longitudinal profile of the river, ending eventually in the destruction of the upland region drained by the river. As a result, it must be anticipated that large quantities of sediment will pass through a river system each year.

The quantity of sediment brought down from the watershed depends on the geology and topography of the watershed; magnitude, intensity, duration, and distribution of rainfall; vegetative cover; and the extent of cultivation and grazing. These variables are subject to so much fluctuation that the quantitative analysis of any particular case is extremely difficult. It is possible, however, to use regression methods to develop a soil loss relationship for a given area from long-term sediment discharge records.

The capacity of a stream to transport sediment depends on hydraulic properties of the stream channel. Such variables as slope, roughness, channel geometry, discharge, velocity, turbulence, fluid properties, and size and gradation of the sediment are closely related to the hydraulic variables controlling the capacity of the stream to carry water, and are subject to mathematical analysis. The total sediment load of a stream is the sum of the bed-material load and the wash load, or bed load and suspended load, or measured and unmeasured load.

Bed-Load Transport

Because bed material is transported as both suspended load and bed load the different physical laws of these modes of transport must be incorporated into any method for predicting total transport of bed material. Transport of bed load is usually related to the tractive force or shear on the bed as in the Du Boys formula:

$$q_b = K\,\tau_o(\tau_o - \tau_c) \tag{12}$$

where

q_b = bed-load discharge per unit width of section per unit time

K = a sediment parameter

τ_o = intensity of bed shear

τ_c = critical shear at which motion is initiated (see Fig. 5).

Bed-Material Transport

As implied by the definitions, the distinction between bed-material load and wash load is of importance. Bed material is transported at the capacity of the stream and is functionally related to measurable hydraulic variables. Wash load is not transported at the capacity of the stream, depending instead on availability, and is not functionally related to hydraulic variables. While there is no sharp demarcation between wash load and bed-material load, one rule of thumb assumes that the bed-material load consists of sizes equal to or greater than 0.062 mm, the division between sand and silt. Another reasonable criteria is to choose a sediment size finer than the smallest 10 percent of the bed material as the point of division between wash load and bed-material load.

Sediment particles which constitute the bed-material load are transported either by rolling or sliding along the bed (bed load) or in suspension. Again there is no sharp distinction between bed load and suspended load. A particle of the bed-material load can move part of the time in contact with the bed and at other times be suspended by the flow. Generally, the amount of bed material moving in contact with the bed of a large sandbed river is only a small percentage of the bed material moving in suspension. These two modes of transport follow different physical laws which must be incorporated into any equation for estimating the bed-material discharge of a river.

The fine material moving as wash load usually will not pose direct problems for development activities in the riverine environment. However, at large concentrations the fine material can influence the capacity of a stream to transport bed material through its influence on fluid properties such as viscosity and density.

For a detailed treatment of currently used suspended and bed-material load transport theories refer to Vanoni (1976) and Simons and Sentürk (1976).

QUALITATIVE RESPONSE OF RIVER SYSTEMS

Many rivers have achieved a state of approximate equilibrium throughout long reaches. For practical engineering purposes, these reaches can be considered stable and are known as "graded" streams by geologists and as "poised" streams by engineers. However, this does not preclude significant changes over a short period of time or over a period of years. Conversely, many streams contain long reaches that are actively aggrading or degrading.

Regardless of the degree of channel stability, man's local activities may produce major changes in river characteristics both locally and throughout an entire reach. All too frequently the net result of a river improvement is a greater departure from equilibrium than that which originally prevailed. Good engineering design must invariably seek to enhance the natural tendency of the stream toward poised conditions. To do so, an understanding of the direction and magnitude of change in channel characteristics caused by the actions of man and nature is required. This understanding can be obtained by: (1) studying the river in a natural condition; (2) having knowledge of the sediment and water discharge; (3) being able to predict the effects and magnitude of man's future activities; and (4) applying to these a knowledge of geology, soils, hydrology, and hydraulics of alluvial rivers.

Predicting the response to channel development is a very complex task. There are a large number of variables involved in the analysis that interrelated and can respond to changes in a river system and in the continual evolution of river form. The channel geometry, bars, and forms of bed roughness all change with changing water and sediment discharges. Because such a prediction is necessary, useful methods have been developed to predict both qualitative and quantitative response of channel systems to change.

Qualitative Prediction of General River Response to Change

Quantitative prediction of response can be made if all of the required data are known with sufficient accuracy. Usually, however, the data are not sufficient for quantitative estimates, and only qualitative estimates are possible.

In more general terms, Lane (1955) studied the changes in river morphology in response to varying water and sediment discharge. Similarly, Leopold and Maddock (1953), Schumm (1971), and Santos and Simons (1972) have investigated channel response to natural and imposed changes. These studies support the following general relationships:

(1) Depth of flow y is directly proportional to water discharge Q.

(2) Channel width W is directly proportional to both water discharge Q and sediment discharge Q_s.

(3) Channel shape, expressed as width to depth W/y ration is directly related to sediment discharge Q_s.

(4) Channel slope S is inversely proportional to water discharge Q and directly proportional to both sediment discharge Q_s and grain size D_{50}.

(5) Sinuosity s is directly proportional to valley slope and inversely proportional to sediment discharge Q_s.

(6) Transport of bed material Q_s is directly related to stream power $\tau_o V$ and concentration of fine material C_F, and inversely related to the fall diameter of the bed material D_{50}.

A very useful relation for predicting system response was developed by Simons et al. (1975) establishing a proportionality between bed-material transport and several related parameters.

$$Q_s \sim \frac{(\tau_o V) W C_F}{D_{50}} \tag{13}$$

where τ_o = bed shear; V - cross-sectional average velocity; C_F = concentration of fine material load. Equation (6) can be modified by substituting γDS for τ_o, and

$$Q = AV = WDV \tag{14}$$

from continuity, yielding

$$Q_s \sim \frac{(\gamma DS) WV}{D_{50}/C_F} = \frac{\gamma QS}{D_{50}/C_F} \tag{15}$$

If specific weight γ is assumed constant and the concentration of fine material C_F is incorporated in the fall diameter, this relation can be expressed simply as

$$QS \sim Q_s D_{50} \tag{16}$$

Equation (16) is essentially the relation proposed by Lane (1955), except fall diameter, which includes the effect of temperature on transport, has been substituted for the physical median diameter used by Lane.

Applications of Qualitative Analysis

Equations (15) and (16) are most useful for qualitative prediction of channel response to natural or imposed changes in a river system. To use a classic example, consider the downstream response of a river to the construction of a dam (Fig. 10). Aggradation in the reservoir upstream of the dam will result in relatively clear water being released downstream of the dam, that is, Q_s will be reduced to Q_s^- downstream.

Assuming fall diameter and water discharge remain constant, slope must decrease downstream of the dam to balance the proportionality of Eq. (16)

$$Q_s^- D_{50}^o \sim Q^o S^- \qquad (17)$$

In Fig. 10 the original channel gradient between the dam and a downstream geologic control (line CA) will be reduced to a new gradient (line C'A) through gradual degradation below the dam. With time, of course, the pool behind the dam will fill and sediment would again be available to the downstream reach. Then, except for local scour, the gradient C'A would increase to the original gradient CA to transport the increase in sediment load. Upstream, the gradient would eventually parallel the original gradient, offset by the height of the dam. Thus, dams with small storage capacity may induce scour and then deposition over a relatively short time period.

The engineer is also interested in quantitative results in addition to qualitative indications of trends. The geomorphic relation $QS \sim Q_s D50$ is only an initial step in analyzing long-term channel response problems. However, this initial step is useful, because it warns of possible future difficulties in designing channel improvement and flood protection works and provides a good first-order estimate of response to all types of river development.

Qualitative Analysis of River Response

Consider next several relatively simple situations commonly encountered by engineers, scientists, and geologists in the river environment. Each case is introduced by a sketch which shows the physical situation prior to a selected natural or man-induced change. Below the sketch, some of the major local effects, upstream effects, and downstream effects resulting from natural processes or development activity are given. It is necessary to emphasize that only the gross local, upstream and downstream effects are identified. For more detail on regimes of flow, bed forms, and resistance to flow and their effects on river response, the reader could refer to Simons and Sentürk (1976).

The initial river conditions are sometimes given in terms of storage dams, water diversions, etc. These examples are used as illustrations relating to common experience. For more details refer to Simons et al. (1975).

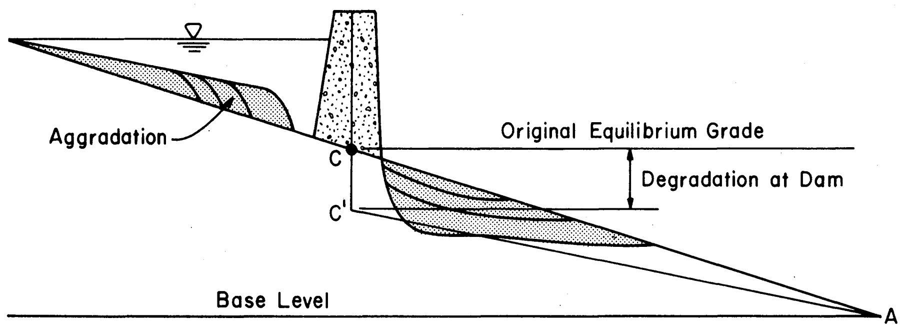
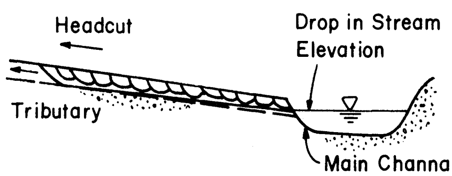


Fig. 10. Channel Adjustment Above and Below a Dam



Local Effects	Upstream Effects	Downstream Effects
1. Headcutting	1. Increased velocity	1. Increased transport to main channel
2. General scour	2. Increased bed material transport	2. Aggradation
3. Local scour	3. Unstable channel	3. Increased flood stage
4. Bank instability	4. Possible change of form of river	4. Possible change of form of river
5. High velocities		

Fig. 11. Lowering of Base Level for Tributary Stream (Simons et al., 1975)

In general, the effect of a storage reservoir is to cause a sudden increase of base level for the upstream section of the river. The result is aggradation of the channel upstream, degradation downstream and a modification of the downstream flow hydrograph. Similar changes in the channel result if the base level is raised by some other mechanism, say a tectonic uplift. The effect of diversions from rivers is to decrease the river discharge downstream of the diversion with or without an overall reduction of the sediment transport. Similarly, changes in water and sediment input to a river reach often occur due to river development projects upstream from the reach under consideration or as a result of natural causes.

Figure 11 illustrates the confluence of a tributary stream with the main stem river. The average water surface elevation in the main channel acts as the base level for the tributary. It is assumed here that base level in the main channel has been lowered by a natural change in the river environment or by man-induced change such as the lowering of a reservoir level on the main stem. Applying Eq. (9), $QS \sim Q_s D_{50}$, to the tributary stream it can be seen that the increase in slope S^+ must be balanced by an increase in sediment transport Q_s^+. Thus, under the new imposed condition, the local gradient of the tributary stream is significantly increased. This increased energy gradient induces headcutting and causes a significant increase in water velocities in the tributary stream. The result is bank instability, possible major changes in the geomorphic characteristics of the tributary stream and increased local scour.

Response to the converse situation, raising the base level, can be illustrated by considering river response to construction of a dam (Fig. 12). Whenever the base level of a channel is raised a pool is created extending a considerable distance upstream depending on the amount of change. This "backwater" effect results in the M_1 curve of gradually varied flow. As the water and sediment being transported by the river encounters this pool, most of the sediments drop out forming a delta-like formation at the head of the pool which slowly advances downstream. The deposition of sediment at the entrance to the pool induces aggradation in the channel upstream. This aggradation may extend many miles upstream after a long period of time, producing significant changes in river geometry, and increased flood stages. Again, Eq. (9) provides an indication of the response. The decrease in slope S^- must be accompanied by a decrease in transport capacity Q_s^- or $Q_s^- \sim Q_s^- D_{50}^o$. In the extreme it is possible that the river may become sufficiently perched that at some high flow it could abandon the old channel and adopt a new one.

As noted in Fig. 12, the effects of raising the base level of the main channel include an increase in base level for any tributaries entering the pool formed by the main stem dam. The impact of this change on the tributaries is shown in Fig. 13.

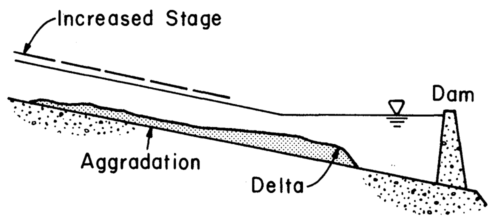
The change in gradient of the tributary stream in most cases causes significant deposition. This can be seen from Eq. (9) where a decrease in slope is accompanied by a decrease

$$Q^{o}S^{-} \sim Q_{s}^{-} D_{50}^{o}$$

assuming constant conditions of water discharge and size of bed material. In this case illustrated, an alluvial fan develops which in time can divert the river or reduce the waterway. In general, streams on alluvial fans shift laterally so that the future location of the channel is uncertain. A similar situation occurs naturally where a steep tributary stream draining an upland region reaches the flatter floodplain of the parent stream.

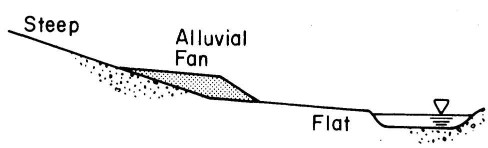
The impact of the construction of a dam on the reach upstream of the dam is outlined in Fig. 12. Construction of an upstream storage dam provides a desilting basin for the water flowing in the system (Fig. 12). In most instances all of the bed-material load coming into a reservoir drops out within the reservoir. Water released from the reservoir is quite clear. The existing river channel is the result of its interaction with normal water-sediment flows over a long period of time. With the sediment-free flows the channel below the dam is too steep and sediments are entrained from the bed and the banks bringing about significant degradation. The channel banks may become unstable due to degradation and there is a possibility that the river, as its profile flattens, may change its plan form. A replot of Fig. 3 is sketched in Fig. 14 to illustrate the possible impact of a significant decrease in slope on channel pattern. Assuming that prior to dam construction the reach below the dam plotted as an intermediate stream (Point 1), the decrease in slope at constant water discharge could move the stream's plotting position to Point 2 in the meandering region of the chart. In the extreme case, it is possible that the degradation may cause failure of the dam and the release of a flood wave.

Figure 15 illustrates a situation where artificial cutoffs have straightened the channel below a given reach. It is obvious that straightening the channel downstream of Reach A significantly increases the channel slope. In general, this causes higher velocities, increased bed material transport, degradation and possible headcutting through Reach A. This can result in unstable river banks and a braided stream form as shown on the sketch of Fig. 2



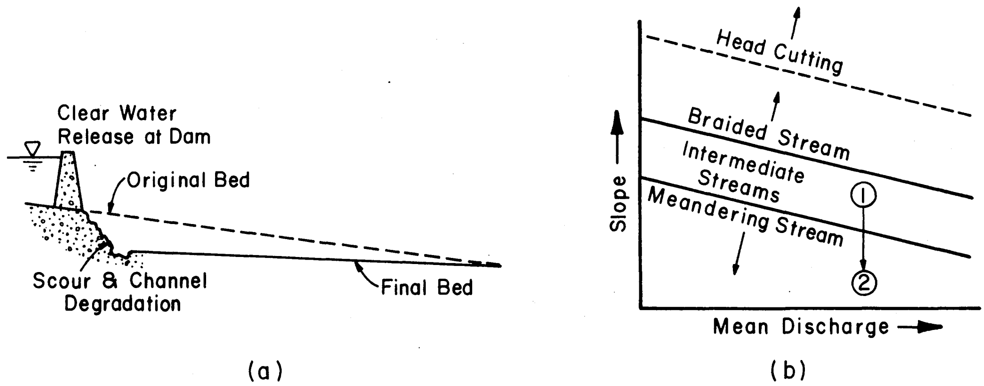
Local Effects	Upstream Effects	Downstream Effects
1. Aggradation of bed	1. See local effects	1. See downstream effects, Fig. 14
2. Loss of waterway capacity	2. Change in base level for tributaries	
3. Change in river geometry	3. Deposition in tributaries near confluences	
4. Increased flood stage	4. Aggradation causing a perched river channel to develop or changing the alignment of the main channel	

Fig. 12. Raising Base Level in Main Channel



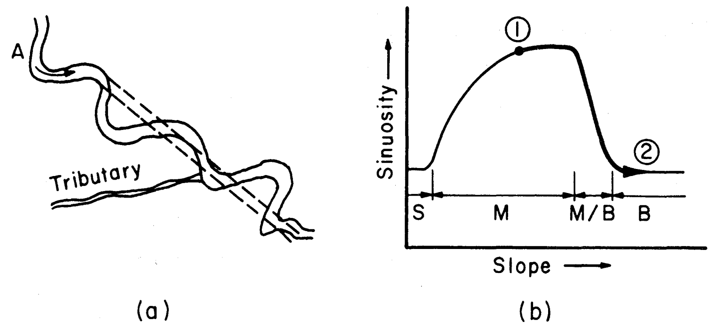
Local Effects	Upstream Effects	Downstream Effects
1. Alluvial fan reduces waterway	1. Erosion of banks	1. Aggradation
2. Channel location is uncertain	2. Unstable channel	2. Flooding
	3. Large transport rate	3. Development of tributary bar in the main channel

Fig. 13. Raising Base Level for Tributary Stream



Local Effects	Upstream Effects	Downstream Effects
1. Channel degradation	1. See upstream effects, Fig. 12	1. Degradation
2. Possible change in river form		2. Reduced flood stage
3. Local scour		3. Reduced base level for tributaries, increased velocity and reduced channel stability causing increased sediment transport to main channel
4. Possible bank instability		
5. Possible dam failure		

Fig. 14. Clear Water Release Below a Dam



Local Effects	Upstream Effects	Downstream Effects
1. Steeper slope	1. See local effects	1. Deposition downstream of straightened channel
2. Higher velocity		2. Increased flood stage
3. Increased transport		3. Loss of channel capacity
4. Degradation and possible headcutting		
5. Banks unstable		
6. River may braid		
7. Degradation in tributary		

Fig. 15. Straightening of a Reach by Construction of Cutoffs

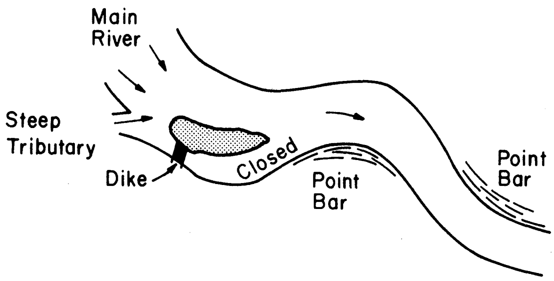
included in Fig. 15. Here, the original plotting position (Point 1) is moved to Point 2 in the braided region by the increase in channel slope. In addition, the straightening of the main channel brings about a drop in base level and any tributary streams flowing into the affected reach of the main channel are subjected to conditions outlined in Fig. 11.

On the other hand, if the straightened section is designed to transport the sediment loads that the river is capable of carrying both upstream and downstream of the straightened reach, bank stability may not be endangered. Such a channel should not undergo significant change over either short or long periods of time. It is possible to build modified reaches of main channels that do not introduce major adverse responses due to local steepening of the main channel. In order to design a straightened channel so that it behaves essentially as the natural channel in terms of velocities and magnitude of bed-material transport, it is necessary, in general, to build a wider shallower section.

The development of an alluvial island below the confluence of a steep tributary is a common feature of the river environment (Fig. 16). The tributary introduces relatively large quantities of bed material into the main channel. As a result of island formation in the main channel, divided flow exists. In an attempt to maintain navigation depths in the main channel it is common practice to close the chute channel by construction of a dike across the subchannel to the island or bar formed by deposition. Such a procedure forces all of the water and sediment to pass through a reduced width. This contraction of the river in general increases the local velocity, increases general and local scour, and may significantly increase bank instability.

In addition, the contraction can change the alignment of the flow in the reach and thus would affect the downstream main channel for a considerable distance. A chute channel can develop across the next point bar downstream and its effect may extend several meander loops downstream. Upstream of the reach there is aggradation and its amount depends on the magnitude of water and sediment being introduced from the tributary. Also, there is significant increase in the backwater upstream of the reach at high flows which in turn affects other tributaries farther upstream. With this analysis the continuity equation, the relationship between discharge and bed-material transport, concepts of rapidly varied flow and the backwater curves all provide indicators of the response to be anticipated.

Among the natural phenomena that can impact the river environment are earthquakes and tectonic activity. Large portions of the United States are



Local Effects	Upstream Effects	Downstream Effects
1. Contraction of the river	1. Aggradation	1. Deposition of excess sediment downstream of the closure
2. Increased velocity	2. Backwater at flood stage	2. More severe attack at first bend downstream
3. General and local scour	3. Changed response of the tributary	3. Possible development of a chute channel across the next point bar downstream
4. Bank instability		

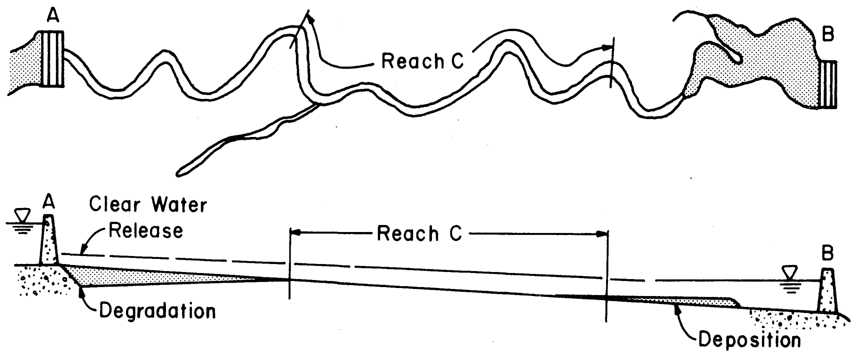
Fig. 16. Closure of a Chute Channel

subjected to at least infrequent earthquakes. Associated with earthquake activity are severe landslides, mud flows, uplifts in the terrain, and liquefaction of otherwise semi-stable materials, all of which can have a profound effect upon channels and structures located within the earthquake area. Historically, several rivers have completely changed their course as a consequence of earthquakes. For example, the Brahmaputra River in Bangladesh and India shifted its course laterally a distance of some 200 miles as a result of earthquakes that occurred approximately 200 years ago. Although it may not be possible to design for earthquake effects, knowledge of the probability of its occurrence is important so that certain aspects of the induced effects from earthquakes can be taken into consideration when evaluating river response.

Figure 17 illustrates a more complicated set of circumstances. In this case a reach of river is affected by Dam A constructed upstream as well as Dam B constructed downstream. As documented in Fig. 14, Dam A causes significant degradation in the main channel. Dam B causes aggradation in the main channel (Fig. 12). The final condition in Reach C is estimated by summing the effects of both dams on the main channel and the tributary flows. The scour below Dam A would make some sedimentary material available for deposition in the reservoir above Dam B, further complicating the situation. Normally, this analysis requires water and sediment routing techniques studying both long- and short-term effects of the construction of these dams.

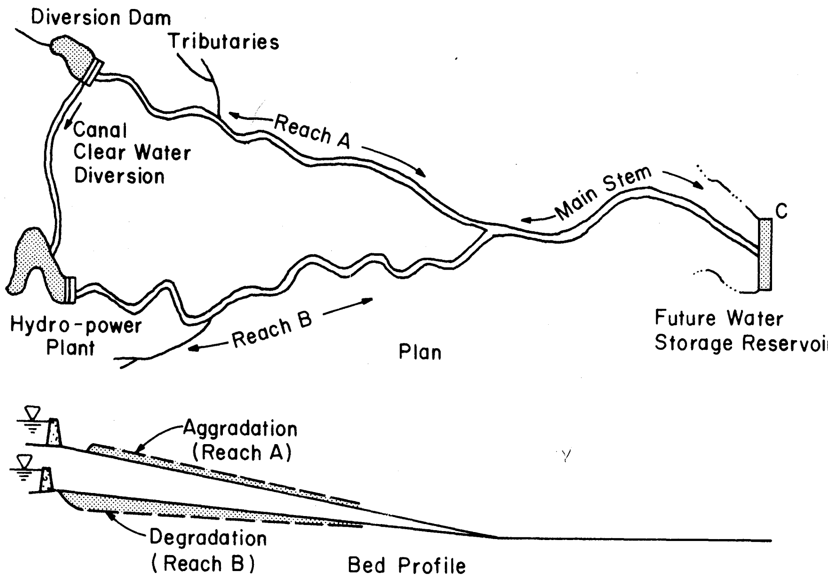
River response to upstream and downstream storage reservoirs on the same stream as analyzed in Fig. 17 can be quite complex. Another situation that is amenable to a basic qualitative analysis involves the response of reaches on two major tributaries a considerable distance upstream of their confluence (Fig. 18). Upstream of Reach A, a diversion structure is built to divert essentially clear water by canal to the adjacent tributary on which Reach B is located. Upstream of Reach B the clear water diverted from the other channel plus water from the tributary is released through a hydropower plant. Ultimately, it is anticipated that a larger storage reservoir may be constructed downstream of the tributary confluence on the main stem at C. These changes in normal river flows give rise to several complex responses in Reaches A and B on the tributary systems as well as on the main stem. Reach A may aggrade due to the excess of sediment left in that tributary when clear water is diverted:

$$Q^{-}S^{+} \sim Q_s^{o} D_{50}^{o}$$



Local Effects	Upstream Effects	Downstream Effects
1. Dam A causes degradation	1. Channel could aggrade or degrade with effects similar to Figs. 12 and 14	1. See upstream effects
2. Dam B causes aggradation		
3. Final condition in Reach C is the combined effect of (1) and (2). Situation is complex and combined interaction of dams, main channel and tributaries must be analyzed using water and sediment routing techniques and geomorphic factors.		

Fig. 17. Combined Increase of Base Level and Reduction of Upstream Sediment Load



Local Effects	Upstream Effects	Downstream Effects
1. Reach A may be subjected to aggradation due to excess sediment left in the channel by diversion of clear water and degradation in tributaries caused by lowering of their base level	1. Upstream of Reach A--aggradation and possible change of river form	1. See upstream effects
2. Reach B may be subjected to degradation due to increased discharge in the channel	2. Upstream of Reach B--degradation and change of river form	2. Construction of reservoir C could induce aggradation in the main channel and in the tributaries
3. If a storage reservoir was constructed at C it could induce aggradation in both tributaries	3. Channel instabilities	
	4. Significant effects on flood stage	

Fig. 18. Clear Water Diversion and Release Combined with Downstream Storage

However, initially there may be a lowering of the channel bed in the vicinity of the diversion structure because of the deposition upstream of the diversion dam and the release of essentially clear water for the relatively short period of time until the sediment storage capacity of the reservoir is satisifed. Reach B is subjected to degradation due to the increased discharge and an essentially clear water release:

$$Q^+ S^- \sim Q_s^- D_{50}^o$$

However, the degradation of the channel could induce degradation in the tributaries causing them to provide additional sediment to the main channel. This response would to some degree counteract the degrading situation in this reach of river. Such changes in river systems are not uncommon and introduce complex responses throughout the system. Any complete analysis must consider the individual effects and sum them over time to determine a response in the reaches of concern.

MODELING OF RIVERS

There are many problems in hydraulic engineering for which the basic equations are known but which are geometrically so complicated that the direct application of the equations is difficult. Many such problems can be solved by the use of models which duplicate this complicated geometry and in which the resulting flow patterns can be observed directly. The models may be physical models; that is small-scale physical replications. They may also be mathematical consisting of mathematical abstractions of the phenomena. Models are used to test the performance of a design or to study the details of a phenomenon. The performance tests of proposed structures can be made at moderate costs and small risks on small-scale (physical) models. Similarly, the interaction of a structure and the river environment can be studied in detail.

The natural phenomena are governed by appropriate sets of governing equations. If these equations can be integrated, the prediction of a given phenomenon in time and space domains can be made mathematically. In many cases related to river engineering, all the governing equations are not known. Also, the known equations cannot be directly treated mathematically for the geometries involved. In such cases, models are used to physically integrate the governing equations. Similitude between a prototype and a model implies two conditions:

(1) To each point, time and process in the prototype, a uniquely coordinated point, time and process exists in the model.

(2) The ratios of corresponding physical magnitudes between prototype and model are constant for each type of physical quantity.

Mobile Bed Models

In modeling response to development works in the river environment, three-dimensional mobile bed models are often used. These models have the bed and sides molded of materials that can be moved by the model flows. Similitude in mobile bed models implies that the model reproduces such fluvial processes as bed scour, bed deposition, lateral channel migration, and varying boundary roughness. It has not been considered possible to faithfully simulate all of these processes simultaneously on scale models. Distortions of various parameters are often made in such models.

Mobile bed models are more difficult to design and their theory is extremely complicated as compared to clear water rigid bed models. However, many successful examples of their use are available. In general, all important river training and control works are studied on physical models. The interpretation of results from a mobile bed model requires a basic understanding of the fluvial processes and some experience with such models. In many cases, where it is possible to obtain only qualitative information from mobile bed models, this information is of great help in comparing the performance of different designs.

Mathematical Models

A physical scale model is a means for extracting information from some source other than from the prototype. With a distorted physical model the geometrical analogy is weakened considerably, but still, under most conditions, the analogy of the overall behavior is strong.

Once one gets used to the idea of looking at a model as an analog computer the next logical step would be to model the process under study on a digital computer in numerical form. This of course requires that a "complete" set of governing equations (some of them differential equations) is available. Such equations would include basic flow equations, the differential equation of nonuniform and unsteady flow, the sediment transport equation, the differential equation formulating continuity of sediment transport, and criterion to predict the bed deformations, just to mention the most obvious equations involved. It is clear that the interaction between these equations is complex. This, after all, is the reason for attempting to model these processes physically. But with the availability of high speed digitial computers it becomes entirely feasible to study some of the characteristics of a river system numerically. Of course the results cannot be better than the basic equations used in the analysis, and most equations available are for one- or two-dimensional flow fields only. But when an overall river system is considered, a river can be viewed as a highly two-dimensional system, and with certain simplifying assumptions a river can be modeled as a one-dimensional system. It is only when one starts looking into the details that three-dimensional processes become important.

Calibration of a mathematical model involves evaluation and modification of the supplementary relations to the basic equations from field data and/or theories such that the mathematical model will reproduce the historical response of the modeled river system. This is similar to calibration of a physical model. To perform the mathematical model calibration, the following information is required: (a) hydrographic maps of the modeled river reach; (b) hydrographs of stage, flow and sediment discharge, and (c) geological and physical properties of the bed and bed material.

From (a), one can evaluate the geometric properties of the river reach. The relations for S_f, Q_s, q_ℓ and V_ℓ can then be evaluated from (b) and (c). If part of data is not available, relations based on experimental, empirical, or theoretical approaches can be used. However, calculated results are only as good as the calibration relations. More specifically, the resistance function for S_f and the sediment transport function for Q_s must be tested and modified to accomplish the model calibration, that is, until the historical data along the river reach can be reproduced by the mathematical model.

The application of mathematical modeling is not limited to the main channels of a river system. The management of watersheds and river basins requires, in general, a complete knowledge of the interrelations between ecology and environment. The watershed response to developments, either natural or man-induced, must be anticipated correctly if progress is to be made towards wise use of our nation's natural resources.

The physical quantities which describe the major watershed response are the water hydrograph and yield, the sediment hydrograph and yield, and the resultant watershed stream morphology. Because the physical processes governing watershed behavior are very complicated many past studies have utilized a statistical interpretation of observed watershed response data. The Unit Hydrograph Method for water routing and the Universal Soil-loss Equation for estimating soil erosion are examples of these types of statistical studies. However, it is difficult to predict the response of a watershed to various land developments or treatments using these methods because they are based on the assumption of homogeneity in both time and space. Numerical modeling using equations describing the physical processes provides a viable method of estimating time-dependent watershed response. In recognition of the necessity of such a model, Colorado State University has developed a numerical computer program employing the formulation of the basic physical processes to determine water and sediment hydrographs and yields from small watersheds.

The Colorado State University (CSU) watershed model, Simons and Li (1975), simulates the land surface hydrologic cycle, sediment production, and water and sediment movement on small watersheds. Conceptually the watershed is divided into an overland flow part and a channel system part. Different physical processes are important for the two different environments. In the overland flow loop, processes of interception, evaporation, infiltration, raindrop impact detachment of soil, erosion by overland flow, and overland flow water (surface and subsurface) and sediment routing to the nearest channel are simulated. In channel system loop, water and sediment contributed by overland flow are routed and the amount of channel erosion or sediment deposition through the channel system is determined.

In the CSU watershed model, emphasis is on the mechanics of water and sediment routing and the model is set up for single storm hydrograph computations. As yet, no attempt has been made to simulate the long-term water balance in the watershed. However, any valid water balance model, such as Stanford Watershed Model IV, can be interfaced with the CSU model.

REFERENCES

Khan, Hamidur, R., 1971, "Laboratory Studies of Alluvial River Channel Patterns," Ph.D. Dissertation, Civil Engineering Department, Colorado State University, Fort Collins, Colorado.

Lane, E. W., 1955, "The Importance of Fluvial Morphology in Hydraulic Engineering," ASCE Proc., Vol. 81, No. 745, 17 p.

Lane, E. W., 1957, "A Study of the Shape of Channels Formed by Natural Streams Flowing in Erodible Material," Missouri River Division Sediment Series No. 9, U.S. Army Engineer Division, Missouri River, Corps of Engineers, Omaha, Nebraska.

Leopold, L. B. and Maddock, T., Jr., 1953, "The Hydraulic Geometry of Stream Channels and Some Physiographic Implication," USGS Prof. Paper 252, 57 p.

Rundquist, L. A., 1975, "A Classification and Analysis of Natural Rivers," Ph.D. Dissertation, Civil Engineering Department, Colorado State University, Fort Collins, Colorado.

Santos-Cayudo, J. and Simons, D. B., 1972, "River Response," Environmental Impacts on Rivers, H. W. Shen, ed., Chap. 1, Water Resources Publications, Fort Collins, Colorado.

Schumm, S. A., 1971, "Fluvial Geomorphology--The Historical Perspective," River Mechanics, H. W. Shen, ed., Vol. 1, Chap. 4, Water Resources Publication, Fort Collins, Colorado.

Shulits, S., 1941, "Rational Equation of River-Bed Profile," Trans., AGU, Vol. 22, pp. 622-630.

Simons, D. B. and Richardson, E. V., 1966, "Resistance to Flow in Alluvial Channels," USGS Prof. Paper 422-J, 61 p.

Simons, D. B. and Richardson, E. V., 1971, "Flow in Alluvial Sand Channels," River Mechanics, H. W. Shen, ed., Vol. 1, Chap. 9, Water Resources Publication, Fort Collins, Colorado.

Simons, D. B., Lagasse, P. F., Chen, Y. H. and Schumm, S. A., 1975, "The River Environment--A Reference Document," prepared for U.S. Department of the Interior, Fish and Wildlife Service, Twin Cities, Minnesota.

Simons, D. B., Li, R. M., Stevens, M. A., 1975, "Development of Models for Predicting Water and Sediment Routing and Yield from Storms on Small Watersheds," prepared for USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Flagstaff, Arizona.

Simons, D. B. and Sentürk, F., 1976, "Sediment Transport Technology," Water Resources Publication, Fort Collins, Colorado.

Vanoni, V. A., Editor, 1975, "Sedimentation Engineering," ASCE Manual and Report of Engineering Practice, No. 54, prepared by ASCE Task Committee for the Preparation of the Manual on Sedimentation of the Sedimentation Committee of the Hydraulics Division.

LEGAL STRATEGIES FOR IMPLEMENTING INSTREAM FLOWS UNDER EXISTING FEDERAL AND STATE LAWS -- RESTORING MINIMUM FLOWS TO ALREADY OVERAPPROPRIATED STREAMS

David L. Harrison
Attorney at Law
Boulder, Colorado 80302

ABSTRACT

Providing for instream flow needs in streams which are already totally diverted by existing water rights is a difficult problem which can only be met by acquiring some existing water rights and transferring them. Although the price for water is high, with the reuse of water for economic purposes after the use for survival flow requirements, some feasible solutions may exist.

INTRODUCTION

Throughout the arid West there are streams which have been long since fully developed. Diversions from these for irrigation, municipal or industrial purposes have in some instances totally dried up streams causing fish kills or other ecological disruptions.

Water throughout the West is a critical resource, and the development of it has given rise to complex institutions and property law systems which cannot be lightly disturbed for some novel, although lofty purpose.

Even success in the great legal debates over whether instream uses should be considered as "beneficial uses," or whether a diversion from the stream is a necessary ingredient in the magic formula for appropriation has little likelihood of affecting the already overappropriated stream.

It is the restoration of streams dried up by prior diversions of water which I will discuss.

THE EXISTING LEGAL SOLUTION

Generally, the arid West has repudiated the common law legal institution of Riparian Rights. Rather to suit its own circumstances, the West developed the "appropriation doctrine" to protect the earliest appropriator from injury by subsequent users. The first in time is the best in right.

And the first in right have not been the fish ecologists. A good hundred years earlier, miners and settlers were digging ditches to help the uncivilized West to bloom. The use of water for the purpose of making money was far ahead of competing uses for aesthetic purposes.

In many states and certainly in Colorado the appropriations that were made are now constitutionally protected property rights. Even the most sweeping legislative reform cannot restore a dry stream without monetary compensation, either in the form of condemnation and fair compensation of certain water rights or selective purchasing.

In other states where a strong state permit system exists and where water rights may not be vested property rights, the same result obtains. As a political and economic matter, if not legal, permit administrators are not able to simply preempt long standing uses for the stream flow purpose without a thorough plan of compensation.

And if your state is like Colorado, you will find a deep seated aversion to the use of condemnation for the acquisition of water rights. The necessity of working out mutually and voluntarily acceptable plans for the purchase of rights or compensation of losses appears to be a common denominator in all states with stream restoration problems.

The federal government's assertion of reserved rights does attempt to relate back past certain existing rights and could theoretically preempt them for restoration purposes. For the most part, however, such rights will still be too junior, or will be at such locations (higher up within the forest boundaries, for example) as to leave the really tough restoration problems untouched.

I conclude, therefore, that the purchase of some water rights is inavoidable. But can it be done as a practical matter? Water rights are hard to buy.

There are institutional barriers to instream uses and to water rights purchases and transfers, generally.

In Colorado the institutional barriers have been substantially relaxed. Senate Bill 97, as it was popularly known when passed in 1973, provides for the possibility that instream uses may exist, at least under the administration of the Colorado Water Conservation Board. Although the rights that they can appropriate outright are the most junior on the stream, there is no reason under Senate Bill 97 that they cannot also acquire other older water rights and change their use to instream purposes.

The transfer of water rights from one use to a new one is legally allowed in Colorado, provided that there is no injurious effect upon other water rights. This is an area of the water law where there has been considerable practice and experience and fortunately there is no basic difference between these transfers and transfers to instream uses.

But water rights in Colorado are very expensive. Is it possible to raise the money among fish lovers to compete with cities, developers and industries for the valuable stuff?

PROPOSED STRATEGY

The fundamental ground rule in transfers is that there can be no injurious effect upon other water users. Each is entitled to the maintenance of stream conditions as when he made his appropriation. Most frequently this ground rule is boiled down to a factual test: The proposed use of water must cause no more depletion than the historic one. In transfers from one irrigation use to another it has meant that the new irrigated acreage cannot exceed the old. In transfers from irrigation to municipal use, the amount that will be actually consumed -- evaporated and not returned to the stream -- must be less than what was historically evapotranspired by the crops.

Herein lies the key. The use of water for stream purposes is essentially nonconsumptive. The only losses are transportation losses, seepage and evaporation, in getting the flow of water through the otherwise dry stream channel. Most of the water arrives at the lower end of the critical reach still West and useable. The water may then be redelivered to another, succeeding use. No injury will occur to other uses so long as the combination of the stream losses and the additional use is no greater than the old use.

If arrangements can be made to resell the water to the downstream user at a price approaching market value, the majority of the acquisition cost can be recovered. The only real cost of water will be for that smaller portion of the total consumption -- stream losses.

My experience so far indicates that the feasibility of acquiring even this portion is marginal. I imagine it will be difficult to provide large attractive, fishable flows of water at all times. We have had some success, however, and some promise of additional success in providing for a "survival flow" -- something lower than "minimum stream flow" as is being developed by the fishery biologists for instream flow needs generally, but a small trickle of water to maintain pools and to circulate some feed and oxygen. Generally, the periods of total stream dry-up have been relatively short crisis periods, perhaps of a couple of weeks duration. The "survival" level of flow would be adequate to prevent some of the fairly frequent fish kills we have observed in some of our streams in Colorado.

The strategy I am outlining has two great selling points. The first is that it can be made to work, at a "survival flow" level, within existing economic realities under existing law or with minimal legislative changes in most states. It is a pragmatic and immediate approach to some specific hard problems.

The second point is responsive to a general political view which I sometimes encounter, holding that the preemption of the scarce water resource for the relatively frivolous purpose of instream use as opposed to the traditional economic uses should not be promoted. My approach maintains that it is possible to serve both sorts of uses at once and thus to promote the real optimization of the whole resource.

The change to successive use for stream flow use and consumptive uses is merely a means redistributing the time and location of competing uses to render them compatible utilizing the traditional approach of acquisition by purchase and transfer to new types and locations of use.

A COLORADO EXAMPLE

On Boulder Creek we have had an interesting experience which tests the proposed strategy. The results there convince me of the essential soundness of the approach for specific tough problems.

Boulder Creek drains a portion of the east slope of the continental divide northwest of Denver and runs into the South Platte drainage system. The upper part of its course is mountainous and there is relatively little agricultural development along it. At the point it exits its mountain canyon and flows out onto the plains, however, a large group of irrigation ditches divert the entire flow of the stream and have legally done so since 1862. The city of Boulder is located right at this point. The stream is a lovely natural artery running through the center of the city and it is of great consternation to many of its inhabitants to watch from the Broadway Bridge the diversion of all the remaining stream flow right in the middle of Central Park.

The city first succeeded in getting the Colorado Water Conservation Board to file a minimum stream flow right of fifteen second feet under the then brand new Senate Bill 97. This right, however, could only get a 1973 priority -- exactly one hundred eleven years too late. Although the claim is effective to prevent future transfers of water rights which will further deteriorate stream flow, it does nothing to restore the barren reach of stream.

Boulder Creek has a surprising amount of potential for a trout population. Countless studies by University of Colorado biology professors and students revealed that in lower reaches of the stream through town where some return flows to the stream low flow pools were supporting natural reproduction of trout. Some of the reaches of stream had been channelized and required some artifically replaced stream habitat and pools, but in general, the system had surprising potential.

The local chapter of Trout Unlimited continued to work on the city officials about the problem. Consulting help was obtained from The Nature Conservancy which is a private action land preservation organization and which had lately become interested in the private acquisition of water rights for stream preservation. Together, a program was worked out using city water rights, which could be used for stream purposes and recaptured for municipal use in downstream facilities.

It works like this. The city owns a substantial amount of water in Barker Reservoir, an upstream mountain area water supply structure. A certain fund of water was directed to be earmarked for the purpose by the City Council. Water is released from storage during times of critically low flow in the amount of two second feet. This water is then credited to downstream users, who take the water in lieu of their own storage releases in a jointly owned downstream storage facility called Boulder Reservoir. Thus, in effect, the water is recaptured and stored again downstream.

The city pushes the matter one step further. At times when the low flow release is not required, they "exchange" the reservoir water back upstream to Barker Reservoir, that is, they release water from Boulder Reservoir to needy downstream seniors in place of their part of the natural stream flow, which is stored by exchange in the upstream reservoir. Thus the earmarked fish flow fund in the upstream Barker Reservoir is renewed and the cycle is completed.

The use of the city's water resources does not, as yet, involve acquisition of specific water rights for the instream purpose, but nevertheless the example demonstrates the strategy. If the city in fact can use some of its unused reserve supply without losing it, the economics of buying the water rights for these purposes is demonstrated.

In fact the city contemplates a need for the water for domestic purposes during severe drouth occurrences, so that on about a twenty year interval the plan may not hold up. If you can, however, convince a city to rotate its reserve water around for instream purposes when not needed for drouth supplies, I encourage you to do so. What it takes to play the game is some existing storage and some needy senior water rights.

A very similar and even more dramatic project is developing on the Cache La Poudre River near Fort Collins. In a scenario very similar to that of Boulder Creek, the Poudre is often times totally diverted at its mouth. Fish kills have often occurred and there is considerable desire to protect the reach of stream from the mouth of the canyon down to the city of Fort Collins.

The Cache La Poudre irrigation system that has developed since the initial appropriations in the 1860's, is the most complex in the state and probably in most of the West. A series of exchanges and trades with storage and direct flow water has evolved to the point that all the water is very carefully and quite thoroughly used for irrigation purposes. The general belief exists among irrigation interests that any sort of minimum stream protection must necessarily disrupt the entire system. It is not necessarily so, however, particularly if water rights are purchased for full compensation and the game is played by the same rules that allows the irrigation exchanges to prosper.

The State Division of Wildlife and the State Water Conservation Board together with the city of Fort Collins, the Trout Unlimited local chapter and The Nature Conservancy, are presently proposing and attempting to develop a responsive program. The city of Fort Collins has upstream storage in Joe Wright Reservoir which it is tentatively committing to the project in the amount of three thousand acre feet. The city water will be released as needed to maintain survival flows of about three second feet. These flows will then be recaptured in downstream storage facilities for trade to irrigators. Stream losses generally being charged on storage releases run about five to ten percent of the the release. Thus, any additional amount of water of about one hundred fifty to three hundred acre feet will need to be made up to keep the city's fund whole.

The market value of water in the area is about $500 to $800 per acre foot although it is rapidly rising. Thus, approximately $100,000 to $200,000 is necessary. The Nature Conservancy, which is in the business of private acquisition of ecologically critical real estate, has expressed a tentative desire to conduct a fundraising for that purpose. Ultimate legal title and management responsibility would be handled by the state.

CONCLUSION

These Colorado examples should be transferrable to other jurisdictions. The basic strategy is one which faces the specific factual situation being addressed, taking advantage of the nonconsumptive use of water for stream purposes, and structuring some appropriate recapture and reuse of the water for traditional uses. Stream losses must be made up. Such factual solutions should be adaptable by permit administrators in fashioning appropriate permit conditions which will protect other existing permittees. The approach can allow the integration of stream restoration with existing uses in such a way as to optimize the water resource without preempting economic uses.

ADMINISTRATIVE STRATEGIES FOR SATISFYING INSTREAM FLOW NEEDS

Dallin W. Jensen
Assistant Attorney General
State of Utah
Salt Lake City, Utah 84114

ABSTRACT

The recognition and protection of instream values has presented a serious and difficult challenge to many of the Western States. Some states have responded to this challenge by adopting programs that recognize instream values or at least allow these values to be evaluated and considered along with other factors in the State's over-all water resource program. These programs are normally implemented by an administrative agency following some sort of legislative endorsement of instream values, although such legislative endorsement has found expression in a variety of forms. In addition to such state programs as allowing an administrative agency to either set or appropriate minimum stream flows, consideration should be given to reserving water to satisfy instream flow needs through state water allocation procedures, and by recognizing such values in the preparation and implementation of state water plans.

INTRODUCTION AND OVERVIEW

Serious efforts to protect and preserve instream values as a part of state water resource programs is of fairly recent vintage in the West. A few Western States have taken rather extensive precautions to protect instream values, while other States have initiated more modest efforts in this area, and some States have almost no program at all to satisfy instream flow needs. Of course, the lack of a comprehensive program in many Western States which recognizes and protects instream values is not too surprising when viewed in light of the historic development of western water law.

The settlement of this region of the country necessitated the utilization of the rivers and streams for mining, agriculture, and other economic purposes. It was only by the rejection of the riparian system of water rights, which existed in the Eastern United States and which required that the water be maintained in the watercourse, that the settlement of this region could be accomplished.[1] The appropriation doctrine, which allowed for the diversion and utilization of the water away from the stream, was in keeping with the goals of society at a time when the emphasis was upon the economic development and utilization of the

Nation's natural resources. Thus, when examined against this background, it can be understood why, during the nineteenth and the first half of the twentieth century, the utilization of our water resources was viewed primarily in economic terms, and why there has been difficulty in some States in achieving a recognition of instream values in their water resource programs. Further, it should be pointed out that the appropriation system of water rights is essentially a law of private water rights. In other words, this doctrine was developed in order to allow private individuals to secure vested rights in the water resource, and was not really geared to the protection of the broader public concerns that have materialized in recent years concerning the need to reserve some water to protect such instream values as fishing, recreation, and the natural stream environment. In fact, the appropriation doctrine was bottomed on a concept which was at odds with leaving water in the stream channel. This concept was the requirement that the water must be diverted from the watercourse and into the possession of the user in order to affect a valid appropriation. Other problems have also presented themselves in efforts to adapt traditional appropriation concepts to satisfy instream flow needs. For example, a valid appropriation could only be accomplished by placing the water which was diverted from the channel to a beneficial use, and since beneficial use was defined primarily in terms of economic uses by the courts in many Western States, this created a further problem for those desiring to reserve water for fish and wildlife propagation, recreation, and other instream uses. The beneficial use requirement effectively foreclosed private rights for these purposes in those States which did not recognize such uses, even though the user may have proposed to divert the water from the channel into an off-channel site and thus comply with the diversion requirement. While some progress has been made in recognizing private rights for instream purposes, and such recognition is a worthwhile step, it does not really reach the heart of the problem. This is so because the problem is not really one of recognizing private rights for these purposes—rather, the need is for a means of protecting instream values by preserving sufficient flow to sustain these values for the public at large. This purpose could not be effectively realized by granting private rights that might exclude the general public from the enjoyment of these instream values once they are established.

Before undertaking a review of some of the specific administrative strategies which might be used to satisfy instream flow needs, a few general observations concerning the role of an administrative agency are relevant. It must be remembered that the administrative agency which may be attempting to implement a program to preserve instream values will be circumscribed in its efforts by the authority delegated the agency by the legislature. In other words, the administrative agency will only be able to fashion strategies for this purpose within the scope of its statutory authority. Consequently, if the state legislature has failed to provide any statutory basis for implementing a program to take care of instream flow needs, the hands of the administrative agency are effectively tied.

Again, it is important to recall the historical function and role of the administrative agency in administering the water resources of a State when making an evaluation of the administrative strategies which may be available to help protect instream flow needs. As noted, the early settlers in the West implemented water use practices which resulted in the judicial, and finally the statutory, adoption of the appropriation system. As the settlement and development of the West progressed, more and more people were using water from a common supply, and conflicts arose when the available water supply would not satisfy all users. The users' only recourse was to use the courts to settle these problems and to achieve some measure of order in the administration of their respective claims. But the courts were ill-suited to provide the continuing supervision of the water resource that was needed for proper water right administration. Thus, the need for administrative control over water use became clear. As territorial governments were created, and as States began to be admitted into the Union, public administration over water resources was conceived. While many of these early efforts resulted in a fairly modest and unsophisticated administrative program, nevertheless the concept of administrative agency control over a state's water resources was born. The continued development and refinement of the administrative structure resulted in a comprehensive water code in virtually all Western States, administered by an administrative agency—usually a State Engineer. Some States, however, have placed this responsibility in the hands of a board or commission. But, however structured, all Western States have an administrative agency having general responsibility for the administration of the state's water resources, including in most States supervision over the appropriation and distribution of the waters of the State.[2]

With continued growth, some States created other water resource agencies to complement water right administration, and delegated to these agencies such functions as creating a state water plan, or constructing state-sponsored water development projects. However, the point to be made here is that state administrative agencies play a substantial and significant role in the water resource program of every Western State. Since the role which an administrative agency may play in satisfying instream flow needs will depend upon the authority delegated to the agency by the legislature it is useful to review some of the legislative techniques that have been adopted to protect instream values.

LEGISLATIVE TECHNIQUES OF RECOGNITION OF INSTREAM VALUES

The recognition that certain instream flow values were a worthwhile and necessary part of a comprehensive state water resource program caused some trauma to water right administrators. Not so much because they were opposed to such a recognition--although some may have been--but because over a period of many years a water right structure had been developed in most Western States which was almost totally committed to the full and complete utilization of the state's water resources for economic purposes. There existed a manifestation of such a developmental policy in legislation, court decisions, and the body of administrative law which had developed over the years to carry out this state policy. Some administrators felt that there was little opportunity to satisfy instream flow needs even if it seemed desirable without some clear change in the public policy of the State. Add to this the realization that in many States the demand upon the remaining water supply for such traditional uses as industrial development for energy purposes, agricultural expansion, and the needs of ever-expanding municipalities has never been greater. Thus, at the very time when the demand for water from streams and rivers for new and expanded consumptive uses is at its zenith, the need is also critical to leave some water in the already-depleted streams, if certain instream values are not to be destroyed.

The challenge is to provide ways for recognizing legitimate instream values, and allowing for the consideration of such values along with competing demands when making decisions which affect a state's rivers and streams. The need is to see that both social and economic values are fairly considered in the decision-making process, in keeping with the over-all public interest and the public policy of the State.

How have the States responded to meet this challenge? Some haven't, but many of the Western States have responded to this challenge by enacting legislation which gives at least some recognition to instream values as a part of the State's water resource program. The National Water Commission in its final report, "Water Policies for the Future,"[3] made certain recommendations for improvements in state water laws to provide for the recognition of social values in water, and in doing so noted some of the more significant legislative techniques that had been adopted to protect instream values. The techniques discussed by the Commission included:

(1) The enactment of statutes which set aside and reserve sections of specific rivers or streams for scenic, recreational, fish and wildlife and related purposes. Some of these acts allow administrative agencies to develop management programs to carry into effect the legislative withdrawal of the waters.[4]

(2) The authorization of an administrative agency to establish minimum stream flows or lake levels to preserve social values connected with the water resource.[5]

(3) Establishing statutory criteria which encompass instream values and which will serve as a guide to the water right administrator in the approval or rejection of applications to appropriate.[6]

(4) The authorization of certain state agencies to file applications to appropriate a portion of the unappropriated stream flow to protect the natural stream amenities.[7]

(5) The requirement that a permit be obtained by state and local governmental agencies before undertaking the alteration or modification of a natural stream channel.[8]

(6) The simultaneous protection of both public and private social values by a public reservation of sufficient water to safeguard the desired stream values.

Of course, the above list of legislative programs is not exhaustive, nor did the Commission intend it to be, but it does clearly demonstrate a fairly wide range of legislative techniques that States are using to bring instream values into their water resource program. While a review and analysis of the entire range of legislative programs which have been initiated to protect instream uses is beyond the scope of this discussion and would invade the province of other speakers at this conference, a few brief additional observations will be helpful to set the stage for the discussion which follows concerning administrative techniques to protect instream values. States, of course, are continually considering legislation which can have the effect of giving recognition to instream values and bringing these values into consideration in water resource decisions.

For example, in recent years a number of states have enacted state water resource acts[9] and state environmental policy acts[10] and while these are two distinct types of legislation such acts, as noted in later sections of this discussion, offer administrative agencies an additional means for considering instream values in their decision-making process. Also, virtually all Western States have authorized the preparation of a state water plan[11] and the planning process can, in most instances, consider instream values, and in many states a water plan, once it is completed, can achieve a regulatory status and thus become an important element in the state's water resource program.

When considering the options which are available to satisfying instream flow needs, it must be remembered that a state may have a number of programs which may directly or indirectly benefit instream values. For instance, reservoir storage, trans-basin diversions, and perhaps even weather modification may augment existing stream flow and thus afford an opportunity to protect existing instream values. Where sources are fully appropriated better water management techniques and more stringent water right administration may offer an opportunity to conserve existing supplies which can benefit certain instream values. Further, a state through its spending power rather than its regulatory power may be accomplishing a part of the state's objectives in the area through such programs as the Fish and Game Department purchasing stored water to be released to sustain a minimum stream flow through certain low periods of the year or purchasing conservation pools in irrigation reservoirs. The point is, it requires a careful and detailed review of each state's programs to understand the full range of techniques that a legislature may have authorized in a given state to protect instream values. Time, of course, will not permit any such analysis in this discussion and it is believed that the time remaining can be best spent reviewing two specific areas which appear to hold some promise in a number of states for protecting instream values. These areas are state water allocation programs and the preparation of state water plans.

ALLOCATION PROCEDURES AS A MEANS OF SATISFYING INSTREAM FLOW NEEDS

Most Western States as a part of their statutory criteria governing the appropriation of water allow the water right administrator to consider the public welfare or public interest in the approval or rejection of applications.[12] This language has existed as a part of the water code in most states for many years and that presents part of the problem. This is so because in many cases there are no legislative guidelines defining what is to be considered when determining the public interest, and to the extent that this term had been defined in most states, either administratively or by court decision, it had been primarily in economic terms. As pointed out above, this is not too surprising when viewed against the historical development of a state's water law structure. However, with the recognition that the public interest is broader than simply economic considerations, the legislatures of some Western States have provided water right administrators with the opportunity to consider certain instream values in reaching decisions on applications to appropriate. Various legislative techniques have been used to bring about the broadening of the public interest in water allocation programs. Perhaps this can be best illustrated by some specific examples. It should be made clear that the use of water allocation procedures are not being suggested as a substitute for other agency action where authorized, such as fixing minimum stream flows or making a direct withdrawal of unallocated water from appropriation. Rather, it is being suggested as only one of the techniques that might be available in a particular state, and it does give the administrator the opportunity to review stream conditions as he makes allocation decisions on a case by case basis.

The Utah experience may be of interest to you in evaluating such an approach. In approving or rejecting applications to appropriate water, the Utah State Engineer is entitled to consider whether an application is detrimental to the public welfare, and also to determine whether the application will interfere with the more beneficial use of the water. However, in Utah as in many other Western States the criteria or factors which the Engineer is to evaluate when considering the public interest was not spelled out in the water code. In other words, the statute simply contains a broad directive that he could or should consider public interest when acting upon an application. Since this statute was enacted at a time when the public interest was equated with economic interest and had been defined by the Utah Supreme Court in primarily economic terms, there seemed to be little opportunity to expand this evaluation to include social values in water without some direction from the legislature that such an approach was desired.[13] Historically, Utah has not looked with great favor on non-economic uses of water. With its arid setting, Utah's legislature and courts early took a position favoring the full utilization of the state's limited water supply. Nevertheless, fishing, hunting, and recreation have developed into substantial industries in Utah, as well as forming an important element in the everyday lives of many residents of the State. And even though the State Division of Wildlife Resources and others had, for many years, expressed a growing concern over the adverse impact continued water development was having on instream values, the existing water code offered little prospect for a solution to this problem. However, in 1971 the Utah Legislature amended the water code, inserting the requirement that in considering new applications to appropriate water, the State Engineer shall determine, in addition to the other statutory criteria, whether the proposed appropriation will ". . . unreasonably affect public recreation or the natural stream environment, . . ."[14] In an effort to insure that Utah's remaining unappropriated water is allocated in a manner that will best serve the over-all public interest and provide a proper balance between developmental interests and the natural stream environment, the State Engineer, through his rule-making power proposed a tentative set of administrative rules which allow for weighing and balancing all factors relating to a proposed appropriation, and approving the application if it is determined that it is in the public interest to do so and rejecting it if it is not. Such an approach would be something of a shift from the manner in which water has traditionally been allocated in Utah. The majority of applications filed have been approved based upon time of filing. With the knowledge that Utah's remaining unallocated water is severely limited and with the great competition for this remaining water, coupled with the concern over certain instream values, it appears that the most sensible manner of allocating Utah's remaining water is by making careful evaluation to determine whether the proposed use is really in the public interest. Proposed rules to implement such a program have been drafted and circulated to interested water user and environmental groups for their comments and criticisms. These rules provide, in part, that:

> In reviewing applications to appropriate water, and in determining whether the particular application under review will interfere with the more beneficial use of water, or will prove detrimental to the public welfare, or will unreasonably affect public recreation or the natural stream environment, the State Engineer will consider:
>
> (1) The public interest aspects of the proposal contained in the application to appropriate, including positive and negative impacts on the economic, social, recreational and environmental values that would result from the proposed use;
>
> (2) The benefits to the applicant that would result from the proposed appropriation and use of water;
>
> (3) The benefits to the State, region and locality that would result directly or indirectly from the economic activity that would result from the proposed appropriation and use of water;
>
> (4) Alternative future uses of the water sought to be appropriated;

(5) Alternative sources of water to satisfy the applicant's needs; and,

(6) Recommendations and data developed by the Utah Board of Water Resources as part of the state water planning process.

After considering, weighing, and balancing the various elements of the public interest as set forth above and the criteria contained in Section 73-3-8, the State Engineer shall approve the application if in his judgment it is in the general public interest, and shall deny the application if it is not.

If adopted, it is expected that this approach would result in a more balanced approach to the utilization and conservation of Utah's water resources.

However, it should be pointed out that the Governor attempted on two separate occasions (the 1975 Regular Session of the Utah Legislature and the First Special Session, June 1975) to implement such a program by an amendment to the water code. Both attempts failed. The legislation passed the Senate on each occasion, but was narrowly defeated in the House of Representatives. Thus, it is suspected that there will be some strong opposition develop over the attempt to do this administratively.

The broadening of the public interest evaluation on applications to appropriate water has been achieved in the State of Washington in a different manner. In light of a fairly recent Washington Supreme Court decision it now appears that the Department of Ecology, which administers Washington's water code,[15] may draw upon other legislative directives in defining the public interest in connection with applications to appropriate water. The Washington Court decision involved the following fact situation. An application to appropriate water from a small lake was challenged by a group of surrounding cabin owners who claimed that the domestic use of this water in the vicinity of the lake would cause pollution problems. The Department of Ecology, in approving the application, primarily limited its review of this matter to the traditional concepts which govern the approval and rejection of applications--the availability of unappropriated water, and interference with existing rights. The Department concluded that the statutory criteria which requires a determination of whether the proposed appropriation would be detrimental to the public welfare did not require an examination of potential pollution problems but was, in fact, limited to the more traditional water law concept concerning whether other water rights would be injured by the withdrawal of the water. However, the Washington Supreme Court disagreed and concluded that water quality considerations were relevant to the Department's decision and remanded the matter back to the agency for further consideration in keeping with its decision. The point of interest here is the basis upon which the Court reached its decision. In 1971 Washington enacted both a Water Resource Act, and a State Environmental Policy Act, and the Court concluded that the provisions of these two statutes applied to the Department's decision-making process in this situation and under them the Department was obligated to consider not only the traditional criteria governing applications to appropriate, but also ". . . the total environmental and ecological factors to the fullest in deciding major matters.[16] Where a state has either a Water Resources Act or a State Environmental Policy Act which indicate a state policy of recognizing fish, wildlife, and other instream values, these would--under the rationale of the Washington decision--offer the water right administrator an opportunity to consider and bring instream values into the decision-making process. Of course, under the mandate of the Washington Court, water right administrators are going to be faced with the very difficult task of achieving a balanced approach between protecting legitimate instream flow needs and developing the state's water resources, and seeing that all interests are fairly brought into the decision-making process.

California has initiated a number of worthwhile programs to protect instream values, one of which deals with water allocation. In California the public interest is the primary standard which guides the Water Rights Board in acting upon applications to appropriate water. Under this standard the Board not only considers a variety of beneficial uses which the particular water may satisfy, but also the protection of certain instream values which may be in the public interest. This has been accomplished by a series of legislative expressions which recognize and provide a means of bringing instream values into the decision-making process.[17]

Since most Western States have provisions in their water codes either allowing or requiring that water right applications to be evaluated in the public interest, an opportunity exists as illustrated by the above examples for water right administrators to bring instream flow needs into the decision-making process where a legislative expression can be found that the public policy of the state favors expanding the public interest beyond traditional economic values. Other phases of the allocation process should also be considered when evaluating strategies to protect instream values.

Where permissable, and when feasible, approvals of certain uses for a fixed or limited time[18] offers a state an opportunity to re-examine the demands on a water source when that use is terminated. By receiving the water back a state would have the option of making the water available for a new allocation or, if allowed by state policy, reserving it for instream needs. Such an option could present an important opportunity to evaluate the demands on stream needs, in light of the changes which occurred since the water was initially allocated.

Even after an application is initially approved there exists an opportunity for the water right administrator to play a further role which could have the effect of making water available for instream uses as well as other demands. This opportunity exists within the framework of the extensions of time that are allowed an applicant after an application is approved. In most states the holder of an approved application is granted a specific time period within which to place the water to beneficial use and submit proof of appropriation. However, for good cause shown, this period may be extended.[19] With dwindling water supplies it would seem that water right administrators are justified in exacting greater diligence from applicants and lapsing applications if the water is not placed to use within a reasonable period. If an application is lapsed the water reverts to the public and is available for re-allocation. If techniques have been developed which allow instream values to be considered along with other potential uses in the competition for this water there will be an additional opportunity to provide water for instream flow needs where it is justified. Of course, this is not the only technique for making certain that the water on a given source is being utilized. Water right administrators also have some opportunity to require that water users achieve a reasonable efficiency in the use of their existing rights and in recommending reasonable and realistic duties of water to the court in statutory adjudication proceedings.[20] Both of which will assure that while water users are given sufficient water to satisfy their needs, no more water is diverted from the stream than is really needed.

While presenting additional policy as well as legal problems, some states may wish to consider the possibility of imposing limitations or conditions on changes of existing rights where such changes could unreasonably harm instream values even though there may be no conflict with existing water rights. The latter criteria has been the only one that has existed in most of the Western States governing the transfer of water rights.

STATE WATER PLANNING PROGRAMS AS A MEANS OF PROTECTING INSTREAM VALUES

State water planning programs provide a vehicle for preserving and protecting instream flow needs. It would appear that virtually all Western States have adopted some form of water planning procedures, and it would further appear that in many cases the development of a state water plan offers an opportunity to protect instream values. This is so because in many states the planning effort has the prospect of achieving a regulatory status, either through the existing authority of the agency creating the plan or by some other means of imposing the concepts developed in the plan on other state and local agencies. If this is the case, then, to the extent that the planning program undertakes a full and careful evaluation of all potential demands upon the state's water resources, and, where conditions justify it, makes recommendations for the protection of instream values, there is some prospect for the protection of these values.

Some states, in authorizing the formulation of a state water planning effort, have specifically recognized that instream values are to be considered in the preparation of such a plan. Such recognition is accomplished directly in the legislation authorizing a planning effort, or by adopting a Water Resources Act which draws such values into the planning process.[21] Other states have simply authorized a planning process without specific planning guidelines, leaving it up to the agency to formulate its own guidelines, but at least directing that a comprehensive look be taken concerning the state's water resources.[22] Of course, it requires a review of each state's statutes to determine the breadth and scope of the water planning program. But, the point here is that it would appear that in many states there exists the opportunity for the planning process to encompass some evaluation of instream values. Consequently, reason exists for those concerned with these values to become familiar with the planning program.

A discussion and evaluation of various planning techniques which will result in a comprehensive water resource plan that is correlated and coordinated with state planning efforts in related fields is beyond the scope of this discussion. However, it can be assumed that most states have allowed the planning agency some flexibility in the planning techniques which it uses and in the method of preparing the plan. In this regard, since water use is related to other natural resource development, a sound water planning program must take place in a framework which allows for an objective evaluation of all present and future needs as well as alternative future uses of water to accommodate identifiable public priorities related to both the conservation and utilization of a state's water resources. Further, water resource planning cannot really be effective if it results in a fragmented and piecemeal approach to isolated problems. This is not to suggest that a single plan must be developed all at once for the entire state. Staff and budget limitations may not only preclude it, but such an approach may be infeasible for other reasons. The preparation of plans for river basins or sub-basins with provisions to correlate the plans with one another and with broader state goals and objectives seems to offer a feasible approach in some states.

While the development of a water plan is appropriately a state function, the chances for ultimately achieving a plan which can be implemented without continued challenges that may ultimately bog it down would seem to best flow from an open planning process that allows for a generous local input from the broadest possible spectrum of water use interests. This will have the advantage, to the extent feasible, of blending local preferences with state goals and objectives, and hopefully will generate broad public support for the plan which is developed.[23] Perhaps a more concrete example will illustrate this point. Trying to get a bill through the legislature of an arid state which would allow an administrator to establish minimum stream flows can be a formidable--if not an impossible--task. On the other hand, sitting down with the residents of an area and reviewing the options available on a local stream may be quite a different story. If, for example, the headwaters of a stream traversing the local area were a good fishery which not only contributed to the comfort and enjoyment of the local residents but also helped to sustain a local recreation industry, there would undoubtedly be a good deal of local support to protect and preserve the instream values in that section of the stream. A planning process which solicits and considers local input could have the effect of securing support for instream flow needs in a particular area, whereas the broader concept of a minimum stream flow act may not generate any support, but may, in fact, engender opposition from local representatives.

Further, independent of any question of local support and of extreme importance to the development of a sound and balanced water plan, there is the opportunity within the planning process to take a fair and objective look at the entire range of potential water demands and insure that both utilization and conservation options, present and future, are reviewed in the context of various rivers and streams. Where a planning program is undertaken with a goal of carefully reviewing all potential uses in a given river basin or sub-basin, the administrative agency will have an excellent opportunity to consider instream flow needs along with other competing demands for the available water supply. The technical phases of the study offer an opportunity to develop data through field investigations, scientific studies and analysis, which can develop supporting data for the recommendations which are being made. The result should be a well-balanced state water plan.

The important point to keep in mind for purposes of this discussion is the realization that in many states the planning process, once the plan is completed, has the realistic possibility of achieving a regulating status wherein it can serve as a flexible guide in the management and utilization of the state's water resources. California[24] and Texas,[25] for example, have provided by specific legislative directive, that while the water right administrator is not bound by such plan, he is required to give it consideration in water allocation decisions. Oregon[26] has likewise required consideration of its planning program in water right decisions, which may affect the public interest. In certain other states, the agency delegated the authority to prepare the water plan has a means of implementing it. For instance, in Nevada[27] the State Engineer who is charged with water rights administration has the authority to develop a comprehensive water resource plan for the state. With this combined planning and regulatory function, it is assumed that planning can assert a substantial influence on water use decisions. This same situation exists in Wyoming.[28] Thus, even in those states where the legislation has been less than clear on how the planning program is to be implemented, there exists the opportunity for implementation where the planning function has been given to a regulatory agency. In Utah, the Board of Water Resources is charged with the responsiblity of formulating a state water plan, but the legislature has not authorized that agency to implement any plan which it develops.[29] However, as can be seen in the proposed rules of the Utah State Engineer, which are set forth above, there is an effort being made to recognize the plan process in water allocation decisions. Consequently, when reviewing available administrative strategies to protect instream values, it is clear that state water planning programs should not be ignored.

CONCLUSION

There exists within the framework of legislative initiatives which have taken place in some of the Western States, a considerable opportunity for administrative agencies to protect and preserve instream values. The foregoing discussion has focused on only some of the legal and practical techniques that are available to administrative agencies in protecting instream values in state water allocation programs and through the preparation and implementation of a state water plan. Additional administrative techniques can be developed in these areas, and other state programs offer similar opportunities for administrative agencies to develop strategies to satisfy instream flow needs. But the task will not be an easy one because of the intense competition which exists in most Western States for the available water supply. Thus, it is going to require the continued effort of all those interested in instream values to achieve a balanced water resource program in the Western States.

NOTES

(1) Hutchins, Water Rights Laws in the Nineteen Western States, Vol. 1, pp. 159-175 (1975).

(2) Dewsnup and Jensen, A Summary Digest of State Water Laws, National Water Commission, pp. 11-16 (1973).

(3) Water Policies for the Future, National Water Commission, pp. 271-279 (1973). For a more detailed discussion of the techniques discussed in the report see Dewsnup, Legal Protection of Instream Water Values, NTIS No. PB 205 003 (1971) and for a review of public access rights to waters and adjacent shorelands see Dewsnup, Public Access Rights in Waters and Shorelands, NTIS No. PB 205 247 (1971).

(4) California Water Code §5093.50, et seq.; and Oklahoma, Okla. Stat. Ann. §1451, et seq.

(5) Washington, Wash. Rev. Code §90.22.010 and §90.22.020.

(6) Utah, Utah Code Ann. §73-3-8.

(7) Colorado, Colo. Rev. Stat. Ann. §37-92-102(3); and Idaho, Idaho Code §67-4307.

(8) Montana, Rev. Codes of Mont. §26-1501, et seq.; and Utah, Utah Code Ann. §73-3-29.

(9) Washington, Wash. Rev. Code §90.54.010 et seq.; Oregon, Ore. Rev. Stat. §536.310; and Montana, Rev. Codes of Mont. §89-101.2.

(10) Washington, Wash. Rev. Code §43.21C.010 et seq.; South Dakota, South Dakota Comp. Laws §11-1A et seq.; and Montana, Rev. Codes of Mont. §69-6501 et seq.

(11) For example, Texas, Vernons Texas Code Ann., Water §11.101; Montana, Rev. Codes of Mont. §89-132.1; Nevada, Nev. Rev. Stat. §532.165; and Wyoming, Wyo. Stat. §41-1.6 and §41-1.18.

(12) For an example of statutes where criteria is not provided in the act to define the public interest see: Arizona, Ariz. Rev. Stat. Ann. §45-143; North Dakota, North Dakota Century Code §61-04-07 (1970); and South Dakota, South Dakota Comp. Laws §46-5-18. States which have included legislative guidelines to define the public interest include Alaska, Alaska Stat. §46.15.080; and Oregon, Ore. Rev. Stat. §537.170.

(13) Tanner V. Bacon, 103 Utah 494, 136 P. 2d, 957 (1943).

(14) Utah Code Ann. §73-3-8.

(15) Wash. Rev. Code §43.21A.020; §91.03.010 et seq.

(16) Stempel v. Department of Water Resources, 82 Wash. 2d 109, 508 P. 2d 166 (1973).

(17) Calif. Water Code §1253-1258. For a judicial construction of this legislation see Johnson Rancho County Water Dist. v. State Water Rights Board, 45 Cal. Rptr. 589, 235 Cal. App. 2d 863 (1965) and Bank of America Natural Trust and Savings Assoc. V. State Water Resources Control Board, 42 Cal. App. 3d 291, 116 Cal. Rptr. 770 (1974).

(18) Utah Code Ann. §73-3-8.

(19) For a review of the various state statutes on this subject see, Dewsnup and Jensen, A Summary Digest of State Water Laws, National Water Commission (1971) Part II.

(20) Hutchins, Water Rights Laws in the Nineteen Western States, Vol. 1 (1971) Chapters 15 and 16.

(21) Oregon, Ore. Rev. Stat. §536.300 and §536.310; and Washington, Wash. Rev. Code. §43.27A.909 and §§90.54.010 and .020.

(22) Nevada, Nev. Rev. Stat. §532.165.

(23) Dewsnup and Jensen, Proposed Procedures for Planning, Allocating and Regulating Use of Water Resources in Utah, Report Prepared for Utah Division of Water Resources, Vol. 1 ch. 2 (1975).

(24) Calif. Water Code §1256.

(25) Vernons Texas Codes Ann., Water §11.105.

(26) Oregon Rev. Stat. §537.170.

(27) Nevada Rev. Stat. §532.165.

(28) Wyo. Stat. §41-1.6 and $41-1.18.

(29) Utah Code Ann. §73-10-19.

DECISION-MAKING STRATEGIES FOR IMPLEMENTING STREAM FLOWS

Berton L. Lamb
Eastern Kentucky University
Department of Political Science
Richmond, KY 40475

ABSTRACT

This paper introduces the notion that decision-making in water resources allocation occurs in an arena which is characterized by adversary relationships among agencies and bargaining. Decision-making itself is a political process which is worked out in this bargaining arena. This arena may be thought of as an amphitheater in which players act out roles.

Four agency roles are identified. These are the roles of "advocate," "guardian," "broker," and "arbitrator." As in other analogus situations the roles condition the type of behavior which will be considered acceptable from each actor. Understanding the roles, therefore, leads to the identification of strategies for action. This paper concentrates on strategies for the "advocate" agencies. Current preferred strategies and new strategies consistent with the role are identified.

INTRODUCTION

The making of decisions about instream flows occurs in a setting characterized by conflict. Even though this is a widely understood fact the reality that such important decisions are not made in a "rational" manner frequently surprises both laypersons and practitioners. Because adversary relationships are the rule it is important to overcome frustration with the seemingly chaotic setting of decision-making. This frustration can be overcome in part if one thinks of decision-making as occuring in an arena. The notion of an arena can lend structure to the decision-making process.

An arena may be thought of as any sphere of interest or activity. It is derived from the notion of an amphitheater in which the actors are confined to a specific space. The instream flow decision-making arena is similarly constrained. Within the general context of water allocation there are identifiable actors, issues, and activities which are peculiar to the establishment and maintenance of instream flow levels. Moreover, these activities take place within the boundaries provided by statute and legal precedent. There is a tangible arena for decision-making on instream flows.

Decision-making refers to the behavior of agencies operating in this arena as they seek to establish policy. Decision-making strategies are those patterns of behavior which facilitate this policy-making process. Just as in an arena full of combatants the outcome is conditioned by the efforts of the strong and the cunning. In short, agency power is important in determining the policy outcome. Sources of agency power in the instream flow arena have been identified in several places.[1] Examples of these sources of power are public support, administrative or physical regulatory ability, access to data, and statutory authority.

Agencies as actors in this instream flow arena enter the struggle with knowledge of their own position and the position of the other actors. This knowledge consists of an understanding of the sources of agency power, recollection of previous agency positions on similar problems, information on the means commonly employed by other actors, and a personal relationship with specific agency's representatives also involved in the arena. The policy outcome depends on how skillfully actors can use their power and knowledge in dealing with adversaries.

Roles as Guides for Strategies

Adopting strategies for implementing instream flows depends upon knowledge of the strategies likely to be employed by others. In order to have this knowledge one needs to understand the context of the particular situation. Important contextual features include the statutory setting of the decision arena, the agencies involved, and the intensity of each agency's involvement. These are factors known to most participants who have experience in negotiating with other agencies.

It is important to know the strategies other agencies are likely to employ. Fortunately, agencies tend to behave rather consistently when they approach this decision-making arena. This means that other agencies can proceed with a degree of certainty. Without this mutual consistency bargaining would be chaotic as agency representatives constantly seek to determine the rules which govern each new bargaining situation.

The strategies that agencies are likely to employ--and those which are legitimate in each situation--are determined by the roles agencies play. These roles are determined by the agency's mission, its support groups, and the specific problem at hand. Based on research into the instream flow decision-making process, four roles have been identified and these have been dichotomized into two categories: activist roles and allocator roles.

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[1] H. R. Doerksen, J. J. Orsborn, F. D. Deane, and B. L. Lamb, Regional Instream Flow Needs in the Pacific Northwest (Pullman: State of Washington Water Research Center, 1975)

As in a game or stage play the role constrains the behavior of the actors or players. To behave in ways inconsistent with one's role will usually be seen as illigitimate by other agencies' representatives as well as one's own colleagues. Sanction against such aberrant behavior can be brought to bear on the responsible actor so that he no longer represents his agency or is excluded from effective bargaining. In brief, once one knows the context of the negotiations one can determine the mix of available roles. From this knowledge one can predict the strategies to be pursued.

Basically, two types of decision contexts have been identified.[2] The first of these is general dispersed authority. General dispersed authority is common among federal agencies, between state and federal agencies, among the states, and within certain states. In this context no agency has the capacity to authoritatively establish a flow regime. The second context is one of centralized authority. This is common in states in which specific agencies have been given the statutory authority to promulgate regulations establishing flow regimes. This is the circumstance in Washington, for example, where the State Ecology Department has statutory authority to establish flows.

These decision contexts suggest which of the allocator roles are likely to be present. The two allocator roles are:

Arbitrators: Those agencies which have statutory authority to establish instream flow regimes. These are usually state agencies which can make policy; they rely on data collected by others and make authoritative allocations after hearing evidence from all sides. They tend to avoid political or public participation strategies, but rely on legal proceedings and management strategies.

Brokers: Those agencies--usually at the federal level--that physically control the streams through impoundments. They are in a position to support either environmental or developmental interests. They tend to prefer cost-benefit analysis, mechanisms for controlling flows, and to some extent political considerations. The latter is preferred due to the nature of the agencies' support groups. The strategy seems to be to play the activist agencies against one another in order to retain the balance of power.

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[2] P. L. Beckett and B. L. Lamb, Instream Flow Decision-Making in the Pacific Northwest, Office of Water Research and Technology, Completion Report, Project A-077-Washington (forthcoming).

The arbitrator is most often found in the context of centralized authority. If an arbitrator agency is present the opportunities to broker decisions are diminished and agencies which control impoundments are cast in one of the activist roles. The broker, on the other hand, is most often encountered on the federal level or in inter-state competition. In this circumstance no agency is in a position to allocate flows but many have a role in flow determination. The broker can control and direct this decision process by casting its weight to either side. This it may choose to do in order to protect its image, reward support groups, fulfill its mission, or facilitate a decision.

In both decision contexts the activist agencies are present. The activist roles are:

Advocates: Those agencies which call for a change in the developmental approach to water allocation. These agencies are often without enabling legislation or are reactive to the initiative held by other agencies. They tend to rely on "crusading" and data to advance their position.

Guardians: Those agencies which attempt to protect the productivity or market utility of the water. These agencies prefer some legal or political strategies such as interest group consultation, public participation, or legal proceedings because they are possessed of established and influential support groups. Moreoever, the thrust of the appropriation doctrine in water law supports their position.

These activist agencies design their strategies to accommodate the presence of an arbitrator or broker. Different activities are pursued within the activist roles depending on the situation. Advocate agencies, for example, often develop alliances with arbitrators because the arbitrators rely on advocates for information and the opportunity to act (e.g., statutes often require advocate agencies on the state level to initiate the decision process).

Reference should be made to Table 1 which illustrates those agencies, that according to studies, are associated with various roles.[3] This table gives the reader a picture of the actor and role present in a given arena. The realities of the instream flow arena require that at least two and usually three roles be represented in each arena. Water allocation is such a controversial problem that there will inevitably be opposing views. These views will be assumed by guardians and advocates. In short, agencies rely on the roles to provide boundaries and guides for the decision process.

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[3] Ibid.

Table 1.--Agency Function as it is Associated with the Type of Role Agencies Play

Agency Function	Type of Role: Advocate	Guardian	Arbitrator	Broker
Land Management		State Forest Agencies	U.S. Forest Service Bureau of Land Management National Parks Ser.	
Power and Flood Control		Federal Power Commission Bonneville Power Administration		U.S. Army Corps of Engineers
Agriculture		Soil Conservation Service Bureau of Reclamation		
Public Health				State Health Agencies Public Health Service
Ecology			Environmental Protection Agency State Environment Agencies	U.S. Geological Survey
Fish and Wildlife	U.S. Fish and Wildlife Ser. State Fish and Game Agencies			
Recreation/ Aesthetics	Bureau of Outdr. Recreation State Parks			

Strategies Which Are Appropriate for Advocates

Each of the four roles which have been identified carries with it a set of appropriate strategies. Some of these strategies are frequently used while others are often ignored. For the purpose of understanding strategies appropriate to implementing flows it is important to know the strategies appropriate for advocate agencies because it is often these agencies which initiate the decision-making process.

The basic confrontation is between advocate and guardian agencies. Advocate strategies have been forged in this mileau. These strategies, which grow out of agency mission and role in the bargaining arena, become reified over time as organizational processes. These processes, or standard operating procedures, reflect agency preferences from among the range of available patterns of activity. Once these strategies become institutionalized, the addition of new strategies is difficult because actors prefer to rely on experience and proven methods.

Advocate agencies, such as those representing fish and wildlife or recreation/aesthetics interests, have developed a repertoire of strategies which fall into this category of preferred procedures. These advocate strategies can be divided into three groups: Data development, crusading, and leaking. Data development refers to the collection and interpretation of data on the hydrographic and aquatic characteristics of streams for the purpose of determining flow needs. This group of strategies goes to the heart of the professional expertise and mission of these agencies. It includes collecting data on the streams in question; analysing these data through the medium of a methodology which indicates the needs of aquatic life; and presenting this data package in an atmosphere which is conducive to a rational consideration of facts.

Interestingly, research shows that it is the advocate agencies which most prefer this group of strategies.[4] This research demonstrates that advocate agencies prefer to use data in the bargaining arena and possibly would like to rely on these strategies more extensively in the future. The emphasis on data development is consistent with agency mission and the professional training of agency personnel. Moreover, these agencies are often required to produce data by statute and consequently must develop data.

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[4] H.R. Doerksen, and B.L. Lamb, "Interagency Decision-Making on Water Resources," Paper Presented at the Annual Convention of the Western Political Science Association, San Francisco, 1976, pp. 5-13.

The difficulty lies in the fact that even when these data can be collected they are not often a powerful bargaining tool. Expertise and data are the advocates' entre to the arena but these can be presented in such a way as to hinder effective communication, or they can be overshadowed by cost-benefit analysis, and the agencies' inability to physically or administratively control stream flow. The importance placed on the agencies' instream flow recommendations is diminished to the extent that the data do not translate into the bargaining language used by other actors.

These data development strategies are further obviated because the data are often not available. If one relies on data development to advance his case when those data cannot be found his position is seriously deteriorated. There are two common problems of this type. First, advocate agencies are often asked to provide input to decisions regarding streams which have not been studied. The time frame for these decisions is usually short which means that adequate data cannot be collected on which to base judgment regarding instream flow needs. A basic difficulty in this regard is that agencies frequently have to respond to these "brush fires" to the detriment of planned data gathering. Therefore, while the agency may set out to systematically study critical streams some of its resources for performing these studies are siphoned off to respond to the "brush fires."

Second, even when the data have been collected controversy continues over the utility of the information. This question of utility in turn has two aspects. Primary among these is the question of methodology. Which methods of data collection and analysis are authoritative? Are these methods specific to streams in a certain basin or region? The plethora of works directed at these and similar questions bear evidence to the fact that this is an important problem.[5] When there is a lack of consensus on methodology the results of data analysis become questionable. The second of these aspects is comparability of data or units of measure. Even though there has been some progress in this area it remains difficult to quantify fish, wildlife, or aesthetics benefits in such a way that they compare favorably with developmental benefits.

In sum, there are major problems associated with utilization of the

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[5] See for example, Doerksen, Orsborn, Deane and Lamb, Regional Instream Flow Needs in the Pacific Northwest, Part II; J.A. Crutchfield, et al. Methodology and Data for Analyzing Qualitative, Quantitative, and Economic Aspects of Minimum Stream-Flow, Vols. I, II (Pullman: State of Washington Water Research Center, 1975); C.B. Stalnaker and J.L. Arnette, Methodologies for the Determination of Stream Resource Flow Requirements: An Assessment (Washington, D.C.: U. S. Fish and Wildlife Service, 1976).

data development strategy. Data are difficult to collect, difficult to compare, and often unavailable. Yet agencies are required to follow these strategies. To the extent that this is the case it may be useful to develop data in ways which translate into symbols the advocate can use in bargaining. For example, data can be developed to meet two goals simultaneously; they can be used for interagency communication as well as for generating public support depending on how they are packaged.

Crusading is another strategy employed by advocate agencies. Studies recently conducted in the Pacific Northwest show this basic strategy to be characteristic of advocate agencies in all levels of government.[6] Intuitively, this strategy seems to emanate from two interrelated phenomena. Representatives of advocate agencies actually see themselves as facing hostile opponents, and as supporting the beliefs of the environmental movement.[7] Representatives of these agencies also are frustrated by the lack of success they experience in preparing and presenting data. Crusading is an attempt to overcome these difficulties through reliance on the tactics of dogged persistence, and negotiation using claims of essentiality and urgency. This means following a rigid position in which advocates point to the bottom line and insist on recognition.

Crusading can be successful. Typically these agencies must be heard in the decision process, and some evidence must be given that their interests have been taken into account. In the face of a dearth of adequate information on the stream in question some progress can be made by simply insisting that instream values be recognized. From that point a stream flow regime can be built incrementally as data become available and opportunities arise. The weakness of this strategy lies in its constant reliance on ultimates and the posture of rigidity which it requires. Guardian and broker agencies eventually come to expect a hard line from advocates and discount demands accordingly. The more one relies on crusading the less value it is likely to have in influencing other actors.

Advocate agencies in the natural resource management arena are unique among advocates generally in that they are weak. They lack a constituency base, financial resources, statutory authority, or a history of success in meeting environmental challenges. The lack of a cultivated constituency base

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6 Beckett and Lamb, Instream Flow Decision-Making in the Pacific Northwest, see especially Chapter III.

7 Ibid. Chapter II.

means that efforts to bring public opinion to bear on the decision-making arena must be outside of regularized channels. This is the strategy of leaking. Leaking refers to a host of tactics for encouraging public involvement when there is no regularized process for doing so.

The idea of leaking is well known to all who follow national politics. In the instream flow arena it has no pejorative connotations, but refers to efforts to develop support when other agencies have already cultivated a supportive constituency. The specific tactics are varied but usually involve the sharing of information on a politically visible problem with a person or group receptive to the agency position. The problems with leaking in this context are twofold. First, because the process is not regularized and the support groups are uncultivated the outcome of leaking is difficult to monitor and hard to predict. One does not know how firm or deep his support may be. The leaked information may bring the support to the surface but without some kind of regularized relationship between the agency and the support group one still faces the problem of evaluating the support. Second, a preliminary look at this strategy indicates that agency representatives are reluctant to pursue it; they use it as a last resort and perceive it to be devious.[8] In sum, while leaking may be valuable it cannot replace regularized support relationships.

It appears that these strategies either arise from or bespeak the weakness of advocate agencies in the instream flow arena. This weakness manifests itself in the uncertainty of environmental values in the stream flow question. A major effort of advocate agencies should be to eliminate this uncertainty. Wildavsky, in discussing means to deal with uncertainty, indicates that the first attempt of advocate agencies is to establish a base and fair share of the resource.[9] Strategies directed in the long run to the development of a consensus on the advocates' base and fair share of the resource will facilitate the protection of instream flows. Base refers to the agreement on the fact that some water must be left flowing in the stream. Even though it is a struggle to maintain this agreement it would seem that one has been reached.

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[8] This topic is considered very briefly in Beckett and Lamb, Instream Flow Decision-Making in the Pacific Northwest, Chapter III.

[9] A. Wildavsky, The Politics of the Budgetary Process (Boston: Little Brown and Company, 1974).

The more difficult problem is to establish agreement on the fair share to be devoted to instream values. Fair share refers to the amount of flow to which advocate agencies are entitled. It is important to underscore the fact that this is not primarily a technical determination.

This is a political decision and technically oriented strategies will be only partially influential.

Public Involvement

While strategies which work toward agreement on a fair share of the resource need to be identified, these strategies must also allow the agencies to fight brush fires as they arise. Several strategies can be identified pending further evaluation: public involvement strategies, management strategies, politically potent argument strategies, and personnel strategies.

Public involvement strategies may consist of several tactics. Among these are, first, the establishment of blue ribbon panels to evaluate the agencies' operations. Judging from the literature in public administration these panels tend to be very supportive of the agency as they become socialized into the agency culture. Their expertise and supposed objectivity make them important bargaining chips. The costs and benefits from such an arrangement need to be evaluated and Office of Management and Budget regulations governing establishment of those panels must be considered in determining the utility of this arrangement. Such a panel would add legitimacy to agency positions, and could become a source of support for agency plans.

Second, is the development of citizen advisory committees. These committees have the benefit of regularizing agency relationships with the public. They are able to communicate to the agency the breadth and depth of public support and to establish a forum for expanding and advertising agency services. These committees would be responsive immediately to challenges to the most visible stream resources. The agency can expect some pressure in the form of demands for expanded services from these committees, but this may be turned to advantage as a justification for increased protection of instream flows.

Third, is interest group consultation. This refers to the structuring of relationships with interest groups identified as supportive. Unfortunately, these groups supportive of advocate agencies are usually seen as irresponsible by guardian agencies. Nevertheless, they have some impact. One technique which may be useful in institutionalizing these relationships would be to appoint a public laison officer with responsibility to keep these groups informed. In this way the groups come to understand agency positions and their support can be monitored.

Fourth, agencies could direct their attention in the opposite direction. In addition to developing public support they could seek the support of elected officials. This may be done by simply initiating routines for informing key legislators. Analysis of the effects of this tactic would be important, but it appears on the surface that these activities would only generate support. The source of the support would be the growing reliance of legislators on information supplied by the agency, increased awareness of agency problems and perspectives, and an understanding of the breadth and depth of public support for agency activities.

Management Strategies

Management strategies refer to those institutional arrangements an agency may enter which would be supportive of its mission. These strategies are positive actions taken to expand the means by which agencies can operate. One can quickly identify two types of management strategies: alliance building, and participation in the planning process. In alliance building, one looks to areas of common interest among agencies. Clearly it would not usually be fruitful to seek alliances with guardian agencies. On the other hand, alliances can be and frequently are formed with broker agencies and arbitrators. Arbitrators, for example, rely on the advocate agencies to supply information, and this can be used as a means to develop common interests. Two tactics follow naturally from this approach. The first is to seek out persons whose professional training makes them receptive to agency positions. For fish and wildlife agencies this person would be a fisheries or wildlife biologist. Agencies can use the ties of profession as a bridge across agency purposes or even jurisdictions. Agencies can develop routines to facilitate contacts among members of the professional guild within the geographical area. This may be done by developing and sponsoring local or regional professional meetings and programs of interest to members of a given profession. These activities are important for reasons of professional growth, employee morale, and the promotion of productivity in addition to whatever alliance building benefits they may have.

The second type of alliance building tactic is to join brokers. When agencies are acting as brokers they usually are under some pressure to complete projects or to prepare recommendations. The advocate agencies have a choice in this case; they can use the urgency of project completion as a lever to gain acceptance of agency views or they can join the broker in an effort to bring the project to a close. This can be done without sacrifice to instream values if the agency representatives are aware of the range of pressures which face the broker agency. It is not necessary to be a rigid opponent of development. Positive attention can be given to developmental projects if they enhance fish and wildlife benefits. This may be done, for example, by assisting in the promotion of projects which will provide flows where they are inadequate, or by supporting irrigation projects to improve wetlands. Not all developmental projects will fall into this beneficial category but some can be supported so that as new forces come to play in the bargaining arena advocates can occasionally ally themselves with the broker. Usually in situations of this kind the rules of reciprocity play an important part and an alliance will have mutual benefits. Agencies can insure that their representatives are sensitive to these opportunities by organizing or supporting training which is directed at altering perception of the instream flow arena.

Participation in the planning process is a more long range tactic, but it may have lasting benefits. The range of planning processes which are available to advocate agencies needs to be explored, but at least one can be identified for purposes of illustrating this point. The process on which the author has done some research is the section 208 (PL92-500) planning process. Under the provisions of this law Governors are supposed to have designated regions for the purpose of planning to meet the 1983 water quality standards. Money to support these plans is provided in full, while funds for implementation are likely. These planning processes can be significantly influenced by advocate agencies. Maximum influence is possible where no state agency has responded to the requirements to develop a plan. The advocate agency may seek to impose itself as the planning agent or it may support and prod an appropriate state agency into action. Both of these tactics require delicacy in order to avoid threatening state agencies, but because the 208 planning process addresses both point sources and nonpoint sources of pollution and involves land use planning it is imperative that advocate agencies have a role in development of the plan.

Potent Arguments

Politically potent arguments are those arguments which in themselves carry weight as bargaining chips. In the case of stream flows these politically potent arguments have to do with famous streams, good fishing streams, exceptionally beautiful reaches of stream, unusual stream characteristics, types of wildlife supported by these streams, and general recreation use. These things have natural attractiveness for bargaining, but this attractiveness can be enhanced. Again this enhancement provides an opportunity for a creative contribution. Moreover, identifying unique streams means these qualitative factors take on the aura of facts. Streams could be ranked for fishing use and production, for example, so that over time as these labels are used they become facts with which all agencies must deal. The notion of the blue ribbon fishing stream is a powerful bargaining tool. Agencies can develop routines for identifying such streams and making them a part of the decision process.

Personnel Strategies

Finally, one can address personnel strategies. These strategies refer to developing the capabilities of agency representatives to respond in creative ways to the problems of the instream flow decision-making arena. There are two basic approaches which would provide the agency with positively oriented personnel: preservice screening, and in-service training. David Barber has identified four categories of personality commonly found among administrators.[10] One particular personality type according to Barber is best suited to management responsibilities. This is the "active-positive" personality. This type of person is energetic, outgoing, and open. Barber believes Harry Truman was this kind of administrator. He had plenty of energy, he fought hard for causes but his attitude was not of one persecuted by his opposition. He retained a positive orientation open to change and innovation. Agencies can seek out these types of persons in their pre-service screening of applicants. Hiring policies which stress broad-based education, an energetic and positive personality, and sensitivity to others may be more important in some cases than technical skills. The agency wants personnel who can be more than technically proficient; it needs good morale, creative responses to challenges, and confidence.

The other type of activity which could promote these qualities is in-service training. This training must go beyond updating knowledge of techniques. Attention should be directed to assisting employees in understanding the positive aspects of the agency role. One tool might be workshops which seek to alleviate the frustrations often encountered by representatives of advocate agencies because of their historically defensive position. An awareness of the positive aspects of the advocate role and the strategies for employing that role in the decision-making arena may improve morale and increase effectiveness.

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[10] J.D. Barber, The Presidential Character: Predicting Performance in the White House (Englewood Cliffs: Prentice-Hall, 1972).

STRATEGIES FOR THE PRESERVATION AND RESTORATION OF INSTREAM FLOWS FOR ENVIRONMENTAL PURPOSES

Robert M. Weaver
Colorado Council of Trout Unlimited
4260 E. Evans Avenue, Suite 3
Denver, Colorado 80222

INTRODUCTION

WATER- a basic requirement for almost everything. Water for drinking, for bathing, for livestock, for crops, for industry, for energy, for waste disposal, for mining, and so on. Water flows in one way or another to virtually everyone, and every special interest seems to have an interest in water, either in the question of how it is used, where it is used, when it is used, or simply whether or not it is used at all in the traditional sense. Not too long ago we discovered that the traditional uses and anticipated needs for water had simply reached such great magnitude that a new need, which had always been taken for granted, had not been provided for. The legal, technical and administrative tools for managing limited water supplies have failed to provide for the most basic, most traditional need of all -- the need for a stream flow.

The fact of the matter is that the needs and benefits of instream flows for fish, wildlife and environmental purposes have been overlooked as a valid use of water resources. In Colorado, where the waters of the state are allocated under the water law doctrine of prior appropriation as in most western states, instream flows have been relegated to the position of the lowest priority "use" of water, and until only recently, instream flows were regarded as a non-use of water or, that is, a non-beneficial use of water. It seems ironic that fish, wildlife and environmental needs under the doctrine of prior appropriation in which first in time is first in right, are the newcomers.

Their needs must be minimized and technically justified. Streams are already over-appropriated or fully committed to anticipated traditional, municipal, industrial and agricultural needs while those who wish to preserve instream flows are left to beg, borrow and steal whatever can be salvaged for the natural environment.

The purpose of this paper is to discuss some of the problems we face in the allocation of limited water resources among competing needs, including the need for instream flows, and the strategies for the preservation and restoration of stream flows for environmental purposes in the state of Colorado, as well as other western states.

The Colorado Water Situation

The mile high state, Colorado, is well-known for its mountain environment and many miles of free-flowing streams. The watersheds of Colorado provide the sources of six major rivers in the western United States. Colorado waters flow to 18 western states and across our national borders to Mexico. It is estimated that there is an average of some 16 million acre feet of water per year available within the state to meet municipal, agricultural and industrial water requirements after downstream compact committments have been fulfilled. The U.S. Bureau of Outdoor Recreation estimates that 3,400 miles of more than 90 Colorado rivers have significant free-flowing environmental and recreational values. Yet, even with such an apparently abundant resource the waters of almost all Colorado streams are fully appropriated or over-appropriated. Further allocations and/or reallocations of water between competing needs including instream flows are and will be matters of great controversy.

Colorado is predominantly a semi-arid state of limited water resources. Conflicts between various appropriators and between appropriators and the general public have existed for a long time and will increase with the increasing demands for water resources. These demands or needs include front range municipal growth, west slope municipal growth, strengthening of Colorado's agricultural base, growing industrial demands, potential energy development, recreational needs, and growing concern for environmental protection. The water resource problem is further complicated by the fact that while most of the surface water flows to the west of the Continental Divide, the greatest growth and demand for municipal, industrial and agricultural water supplies is taking place to the east of the Divide. Thus, massive trans-continental divide water development projects have been built and more are planned. These projects divert small delicate streams from high in the watersheds of the west slope through systems of pipelines, canals and tunnels to the east slope and pose a substantial threat to stream flows and the environment.

The allocations of Colorado's water resources to the wide variety of needs is administered by the courts through water adjudication proceedings in accordance with the Colorado Constitution Doctrine of Prior Appropriation. Article XVI, Section VI of the Colorado Constitution states: "The right to divert the unappropriated waters of any natural stream to beneficial uses shall never be denied. Priority of appropriation shall give the better right." According to Felix L. Sparks, Director of the Colorado Water Conservation Board, " a major legitimate concern today is that the policy of state water development expressed in the Constitution promotes and encourages the destruction of perennial streams and lakes in their natural states. The Constitution provides for maximum utilization of Colorado's water resources by diversion. . ." The water courts must manage Colorado water resources under this law without consideration of economic, social and environmental factors.

In regard to the public's and state's determination of its future, it is interesting to note that in a report dated December, 1972, to Governor John A. Love on Colorado water law problems it was stated that "present Colorado water law does not afford protection for non-economic values" of water and that the "Constitution as interpreted to-date does not allow direct choices to be made between the competing applicants for water rights on the basis of merit." It now seems to be clear that further water resource allocations will require some administrative determination of long-range state goals and priorities so that water priorities can be determined wisely in accordance with the public interest. Unfortunately, many interested citizens and officials do not have an understanding of Colorado water resource problems, present needs and plans, future requirements, and possible environmental, social and economic repercussions of various alternatives.

To most of us in Colorado, the aesthetic, social and economic values of our free-flowing streams are obvious. We do value the magic of the high country, the mountain valleys, the wildlife and the free-flowing streams, and these resources are one key factor in tourism which is critical to the Colorado economy. However, an analysis of what has been happening to our free-flowing streams shows that the trend is away from these values. The Colorado Division of Wildlife estimates that there currently are approximately 9,400 miles of streams that contain fish of which 8,700 miles contain trout. Fish life has been eliminated from over 2,800 stream miles by dams, channelization, pollution, siltation, etc. Since 1900 over 220 stream miles have been lost directly to on-stream construction of reservoirs while another 2,200 stream miles are subject to de-watering from these projects. The Division of Wildlife estimates that within the next 25 years we can expect to lose another 250 to 500 stream miles to water development projects alone. They estimate that the fishery value of such streams to the state of Colorado ranges from $28,500 to $50,000 per stream mile.

Looking to the future, we find that all the streams, with the exception of a few in the far eastern part of Colorado, are already over-appropriated.

That is, if and when all of the decrees for water rights are exercised there will not be enough water to go around let alone enough water to preserve or restore in-stream flows for environmental purposes. At this time water developers are actively promoting over 250 major water development projects to exercise these water rights. In addition to this, Colorado as well as many other western states, is now faced with federal plans for major, accelerated development of coal and oil shale. This could mean massive strip mining, rapid population growth in currently undeveloped areas, coal fired power plants and gassification plants -- all with attendant dams, roads, air pollution and water pollution problems.

The Environmental Position

From the point of view of those of us who are seeking to protect the environment, we fully support and intend to work for strong provisions for instream flows in future water development projects as well as restoration of adequate instream flows where they have not been established in the past. However, instream flows are only one factor which must be considered in the context of the whole issue of fish and wildlife habitat protection. Conservation organizations such as Trout Unlimited will support instream flow measures where and if water development projects must be built, as long as the establishment of instream flow provisions does not serve to facilitate massive water resource development for the sake of development, where the environmental, social and economic benefits are questionable.

In other words, whether or not instream flows requirements are met, many water development projects now being planned will substantially damage fish and wildlife habitat. One of the main principles of conservation which we intend to stand by, is that development and consumption of our natural resources that can be forgone today will result in more options and better possibilities for sensible solutions tomorrow. We believe that it behooves us all to save a few of the best dam sites for the benefit of dam builders of future generations.

The Tools and Strategies for Instream Flow Protection

Unfortunately, there are presently no laws, either federal, state or local, which actually designate minimum stream flows with the exception of flows that junior water diversions must pass to meet the requirements of downstream senior diversions as well as interstate and international compact commitments. Even stream flows required to meet downstream water rights and/or compacts can be intermittent or shut off for certain periods of time when the downstream senior rights are not being exercised.

However, there are several federal laws which provide helpful tools for protection of instream flows. These laws include the National Environmental Policy Act, the Fish and Wildlife Coordination Act, the Federal Water Project Recreation Act, the Water Pollution Control Act Amendments of 1972, the National Wild and Scenic Rivers Act, and the Wilderness Act, and while they do not necessarily require or provide for instream flows, they do provide important political leverage which can often be effective.

The National Environmental Policy Act (NEPA) is a useful tool where federal agencies or lands are involved in water resource development. Through NEPA an environmental impact review process can be required which provides for an inventory and description of the existing environment, a description of the proposed action, an analysis of what that action will do to the environment, an investigation of alternatives and also public involvement. Full disclosure of project plans and repercussions can often stimulate public interest and political support for environmental safeguards such as instream flow requirements.

The Fish and Wildlife Coordination Act provides that:

> " . . . whenever the waters of any stream or other body of water

> are proposed or authorized to be . . . controlled or modified for any purpose whatever, by any department or agency of the United States, or by any public or private agency under federal permit or license, such department or agency first shall consult with the United States Fish and Wildlife Service . . . and with . . . the agency exercising administration over the wildlife resources of the particualr state wherein . . . " the project is to be built.

The Act also allows federal agencies to modify projects or add project facilities which will benefit fish and wildlife resources or minimize the losses.

The Federal Water Project Recreation Act provides for federal funding of 75% of the costs of project facilities which benefit fish and wildlife or enhance recreation. This act helps make up for what the Fish and Wildlife Coordination Act lacks in funding.

The Water Pollution Control Act Amendments of 1972, while aimed primarily at water pollution problems, may prove to be a useful tool for preserving instream flows. For example, Environmental Protection Agency regulations require that the Colorado River basin states adopt water quality standards for salinity and an implementation plan for the control of salinity, and that the salinity in the lower Colorado River should be maintained at or below the average salinity of 1972. As the upper basin states like Colorado proceed to develop their compact allocated shares of Colorado River water, maintaining the 1972 salinity levels will be increasingly difficult because of smaller dilution flows in the river. Thus, the 1972 amendments could become an inhibiting factor to water developments which decrease stream flows and/or have the effect of increasing the concentration of pollutants including not only dissolved solids but also temperature or pH.

Tha National Wild and Scenic Rivers Act as well as the Wilderness Act, while not actually designating minimum or optimal instream flows, can effectively prevent projects which would deplete stream flows. These acts can also be effectively used to the benefit of instream flows where water projects are being planned. An example of this is the Dolores River in Colorado which was included in a bill passed by Congress in 1974 to provide for the study of several rivers for possible inclusion in the National Wild and Scenic Rivers System. There was a great deal of controversy over inclusion of the Dolores River in the study bill because of an authorized Bureau of Reclamation project, but a compromise was reached which provided for the study of the Dolores River under the assumption that the dam would be in place. The studies are now complete and show that the Dolores River Project is compatible with designation of the river and that project water supply needs, if managed properly, will be compatible with instream flow needs. If the Dolores River is designated and the project is built, it will help insure that future possible changes in the operation of the project do not adversely affect instream flow requirements. I know of no case when a river has been actually designated for inclusion in the National Wild and Scenic Rivers System in conjunction with project authorization or funding, but this concept is a potential strategy for protection of instream flows.

Wilderness designation in Colorado has been and hopefully will continue to be a useful tool for instream flow protection by preventing the construction of diversion projects within designated wilderness or areas inventoried by the Forest Service as roadless to be studied for possible wilderness designation. Almost all of these areas encompass high altitude mountain ranges and watersheds where there are no significant diversions upstream. However, there are conflicts in several areas like the Gore Range-Eagles Nest area near Vail, Colorado, where diversions are planned at altitudes of over 9,000 feet so that water can be diverted by gravity flow from the west slope of the continental divide to the east slope many miles away. If areas such as this can be designated as wilderness, it would force the water developers to divert streams at lower elevations where the streams are larger and more capable of supporting diversion without severe dewatering.

In cases where there are wilderness areas, parks or other federal lands downstream from diversions or anticipated diversion projects, if is probable that instream flows can be established and protected under the Reservation Doctrine. There appears to be adequate precedent for the United States to establish reserve water rights for national forest purposes including instream flows for environmental purposes, with priority dating back to when the National Forest was set aside. However, the question as to how much is reasonable for these purposes has not been resolved, but the Forest Service and the Colorado Division of Wildlife are currently developing methods for determination of instream flow needs.

Another useful tool for protection of instream flows in Colorado is Senate Bill 97 which was enacted by the state legislature in 1973 and makes it possible for the Colorado Water Conservation Board to appropriate water or purchase water rights for the purpose of instream flow for environmental and recreational purposes. This was done by amending the definition of beneficial use of water to include instream uses and charging the Colorado Division of Wildlife with the job of making stream flow recommendations to the state Water Conservation Board. S.B. 97 is intended to provide a reasonable degree of legal protection to the natural stream environments of Colorado within the existing legal framework of water law.

Even though S.B. 97 appropriations will be the most junior decrees where streams are already over appropriated, the state is given better standing in court to appear on behalf of the stream in water cases such as applications for changes in use, places of use, points of diversion, etc. The state is now obliged to represent environmental water users, including fish, in various kinds of water court proceedings rather than, or in addition to, those who are seeking only to protect their own traditional type water rights.

In addition, S.B. 97 also makes it possible to convey water rights to instream flow purposes through donation, sale, lease or otherwise so that the water could be legally administered for instream flow purposes.

It is the strategy of Trout Unlimited and other conservation groups to not only work within the existing laws and tools available to prevent environmentally unsound water projects and protect stream flows but also to work for more creative interpretations of existing laws to protect streams. For example, Trout Unlimited and other conservation groups in Colorado have filed our own claims for water rights for environmental preservation purposes which are currently pending in Colorado water courts.

Conclusion

While there are many existing tools to provide for establishment and protection of instream flows, the tools are complicated for environmental organizations to use, they are fragmented and apply primarily to public lands, and the final determination of how effectively the laws are applied is largely political. Laws like S.B. 97 must be given time to work before their effectiveness can be accurately evaluated, but unfortunately, it appears that we do not have much time left.

Even though Colorado has made progress by at least establishing recognition of the need for instream flows, the state still has a policy which dictates full development of the compact allocated shares of waters of rivers flowing from the state as fast as possible. This leaves little time and flexibility in the development of state-wide policies on water use that could be used in such a way as to carry out goals with regard to growth distribution patterns, energy development, industrial development, sub-division, environmental protection, etc.

In Colorado, we not only intend to make best use of the existing laws but will continue to work for policies and laws which place higher priority on stream flows and environmental protection. Substantial progress has been made in the area of instream flows, but decisions in the use and allocation of water resources, as with other natural resources, are becoming more and more complex and increasingly important to our future economic, social and environmental well-being. The most important factor to be kept in mind in our efforts to find solutions to these problems is the growing importance of finding long-term solutions, even though long-term solutions almost always mean short-term sacrifices.

TOPIC II-A.

STRATEGIES FOR IMPLEMENTING IFN

Summary Discussion

The panelist topics dealt with strategies--legal, administrative, decision and pressure group--for reserving flows. The discussion focused on many of these and dealt primarily with questions of law. The salient points which were made include:

1. The right of eminent domain (condemnation) apparently has not been exercised to obtain an instream flow right. While this is probably possible in some states, it should be used delicately, if at all.

2. One strategy would be to purchase a right in an upstream area for delivery downstream, move the water through hydroelectric facilities (thus generating income) and sell the water right at the delivery point at a profit. Water right purchase has been used for refuges (proposed now for Pyramid Lake), as conservation pools for low flow releases, and is an available method in several states.

3. Because of the rights of junior users, any "reallocation" through purchase of water rights and/or transfer of point of diversion cannot damage junior users without compensation.

4. Not just anyone would sell a water right, so use of the purchase strategy involves finding a seller and/or finding creative ways of obtaining a water right for streamflow without damaging present users. It is not always necessary to purchase an entire water right; purchase of a portion (e.g., right to transfer) may be sufficient.

Notes by panel moderator: Harvey R. Doerksen
Steering Committee Member

AN ASSESSMENT OF WATER QUALITY RELATIONSHIPS TO FLOW IN STREAMS AND ESTUARIES

D. B. Porcella and W. J. Grenney
Division of Environmental Engineering
Utah State University
Logan, UT 84322

ABSTRACT

A brief list of models and a statement of concepts illustrated by dissolved oxygen dynamics are used to summarize the relationships between specific water quality parameters and stream flow and estuarine inflow. These relationships are sufficiently developed so that it is appropriate to develop a handbook of acceptable methods for managers, field workers and researchers to assess the effects of flow alteration on aquatic ecosystems.

OVERVIEW

Unaltered aquatic ecosystems usually have wide natural variances in flow. When the fluctuations are damped or the flow is otherwise modified, long established interdependencies in the system may be disturbed. Natural resource managers require quantitative measures of the interference to natural phenomena which result from these disturbances in order to assess the ecological, economic, and technological costs and tradeoffs which result from the manipulation of flow. One subset of these interferences pertains to chemical and microbiological responses to flow. These responses are quantitatively linked to flow and can be used as target variables directly for management or as indicators of conditions important for survival of fisheries or wildlife. Because quantitative relationships between flow and various chemical and microbiological parameters have been determined, it has been possible to develop mathematical models which predict the effects on water quality of various management strategies concerning various flow alterations and patterns. One of the utilities of models is that they allow assessment of alternatives prior to actual manipulation of the system.

During the September 1975 instream flow workshop held at Utah State University through the U.S. Fish and Wildlife Service, a report containing definitions, discussion, and data needs for models that had been described in detail was discussed with a goal of developing a methodology for determining stream resource flow requirements (Stalnaker and Arnette, 1976); the result of the workshop was a refinement of that report. Persons actively involved in the water quality work group summarized the present state-of-the-art of water quality modeling by stating the relative accuracy and precision of models currently used in managing water quality (Table 1). This brief paper illustrates the concepts in the chapter and defines the next important step in managing stream flows.

Where good understanding of physical and chemical processes exist (e.g., dissolved gases, temperature and dissolved solids), modeling is relatively faithful to the actual system or prototype. This duplication of natural conditions is usually achieved by calibration (i.e. the manipulation of coefficients but not input data) so that the calculated output results will approximate a set of actual observations. Verification of a model occurs when model output results are compared with an actual system which has not been calibrated. Another important concept about modeling is resolution which deals with the fineness of details (time and space) of the processes modeled and the input and output data.

Any quantitative relationship between an independent variable and the dependent variables (usually the target variable for management) is defined as a model. For the systems listed in Table 1, many of the important relationships of aquatic ecosystems have been defined. Those models which yet require further definition are listed in Table 2. However, even though considerable work still remains to refine these models, they already can be extremely useful in managing stream flow and estuary inflows. As an example of how to manage an aquatic ecosystem and how a water quality parameter can interact with flow, we will discuss briefly and only conceptually a specific case example.

MANAGEMENT OF FLOW AND WATER QUALITY

A Conceptual Example Using Dissolved Oxygen (DO)

Dissolved oxygen is a good target variable to use as an example because of its interaction with many of the other significant water quality parameters, its relatively ease of measurement in the field, and because it is so essential to fish and other aquatic wildlife. The complexities of the oxygen system make it necessary to use modeling techniques in order to quantitatively interpret these relationships. It is necessary to be aware that there is no absolute standard for DO in aquatic ecosystems, but that DO concentrations are important relative to the uses of the water. For example, the USEPA has specified a water quality standard of 5.5 mg/1 of DO (the states have accepted this or used a more restrictive level) which apparently is minimal for most desirable fish and wildlife, i.e. the use has defined the standard (NAS-NAE, 1972).

Table 1. Water quality parameters in relation to analytical methodologies.

Water Quality Characteristics	Level of Current Analytical Approaches	
	Level I*	Level II**
Dissolved gases - O_2,		a
Temperature		√
Sediment		
Suspended	c	
Bedload	c	
Total dissolved solids		b
Nutrients	d	
Detritus	e	
Toxic materials	√	
Bacteria		
Pathogens	√	
Decomposers	√	
Algae		
Planktonic	√	
Sessile	√	
Macrophytes	not available	
Macroinvertebrates	f	

*Level I - low to moderate accuracy, less precise.
**Level II - highly accurate, precise.

[a]With the exception of benthic O_2 production and demand.

[b]With the exception of chemical phenomena such as $CaCO_3$ solution and precipitation.

[c]With the exception of methods for channel change effects (bank sloughing, aggradation, migration)

[d]Techniques at Level II are available in many situations.

[e]Limitations with measurement and characterization.

[f]Available only with extensive and careful data acquisition.

Table 2. Specific relationships needed to improve modeling of the most important water quality parameters in streams and estuaries

Model Title (target variable)	Required Input Variables*	Research needed to refine model output to obtain highly accurate and precise results
Dissolved Gases O_2 (DO)	CBOD, NH_4^+, gas transfer coefficients, temperature	photosynthetic inputs (light, nutrients, biomass effects) from benthic, rooted, and planktonic producer communities; benthic oxygen uptake in sediments, relationships of rates to temperature
Sediments Suspended (SS)	Universal soil loss coefficients, percent cover, soil type and structure, precipitation	linking of runoff - erosion models with transport - deposition models, channel changes caused by flows
Nutrients (C,N,P)	Loading rates, concentrations, productivity, benthic inputs and cycling effects	chemical relationships for phosphorus solubility (pH, calcium, sediments), nitrogen and phosphorus relationships to growth, kinetics of growth
Toxic materials (heavy metals, organics)	Loading rates, concentrations and effects on biological responses throughout the life cycle	chemical relationships in natural waters (chemical modeling), kinetics of toxicity
Micro Organisms (Bacteria, algae)	Loading rates, dieoff and stimulation, interactions with other growth	interactions with chemical and physical parameters which limit or control growth
Comprehensive, high resolution models	All of the above	overall linkages between models

*All models require specific hydraulic, hydrologic and geomorphologic data for the aquatic system of interest.

The DO level is a function of at least the physical, chemical, and biological variables shown in Figure 1. All of those relationships have been modeled for various river basin applications. The scheme in Figure 1 does not show an explicit relationship between flow and DO nor interactions with diurnal or seasonal time but does differentiate between controlling variables (ovals), directions of net DO flow (arrows) and the important activities or processes which affect DO (rectangles).

However, the input (exogenous) variables (light, temperature, flow) will change with time and space and result in changes in all processes. The frequency of inputting data and/or obtaining output results (hourly, daily, weekly, monthly, seasonally, or annually) and the length of reach will determine the time and space resolution of such a model. This must be determined based on the goals of the project.

Many of the processes for a specific site will be non-existent or negligible, depending on local conditions. However, the physical constraints on the system are always operative and have to be determined as input data: flow pattern and intensity, geomorphological description, turbulence, ppO_2, barometric pressure, temperature, material loadings (salts, nutrients, organics, toxicants). These variables in turn constrain the saturation oxygen level and the mass transfer rates of oxygen across the air-water interface and the production and respiration of the system. The interaction of mass transfer, productivity, and respiration result in a specific DO level in the system. Other organisms and other uses of the water from the system vary as a function of the DO level and with other non-DO system parameters.

Management of DO by Flow Alteration

If the model is operating accurately and precisely, then we can ask pertinent questions about the effects of flow alterations; alternatively, we can state a required DO level and determine the flow regime necessary to attain that DO level. Using the latter approach, we would use existing, specified environmental conditions and the DO levels specified in stream standards (4 mg/l DO/l, minimum requirement 5.5 mg DO/l, USEPA; 6.0 mg DO/l, State of Utah) or specified for certain fish species (e.g. Doudoroff and Shumway, 1970). The former approach would be based on developing a family of curves relating DO levels at different points for different times of the year to particular flow conditions for prototype environmental conditions; then the manager would compare the calculated DO levels (environmental "costs") to the different flow regimes (economic costs and benefits of development).

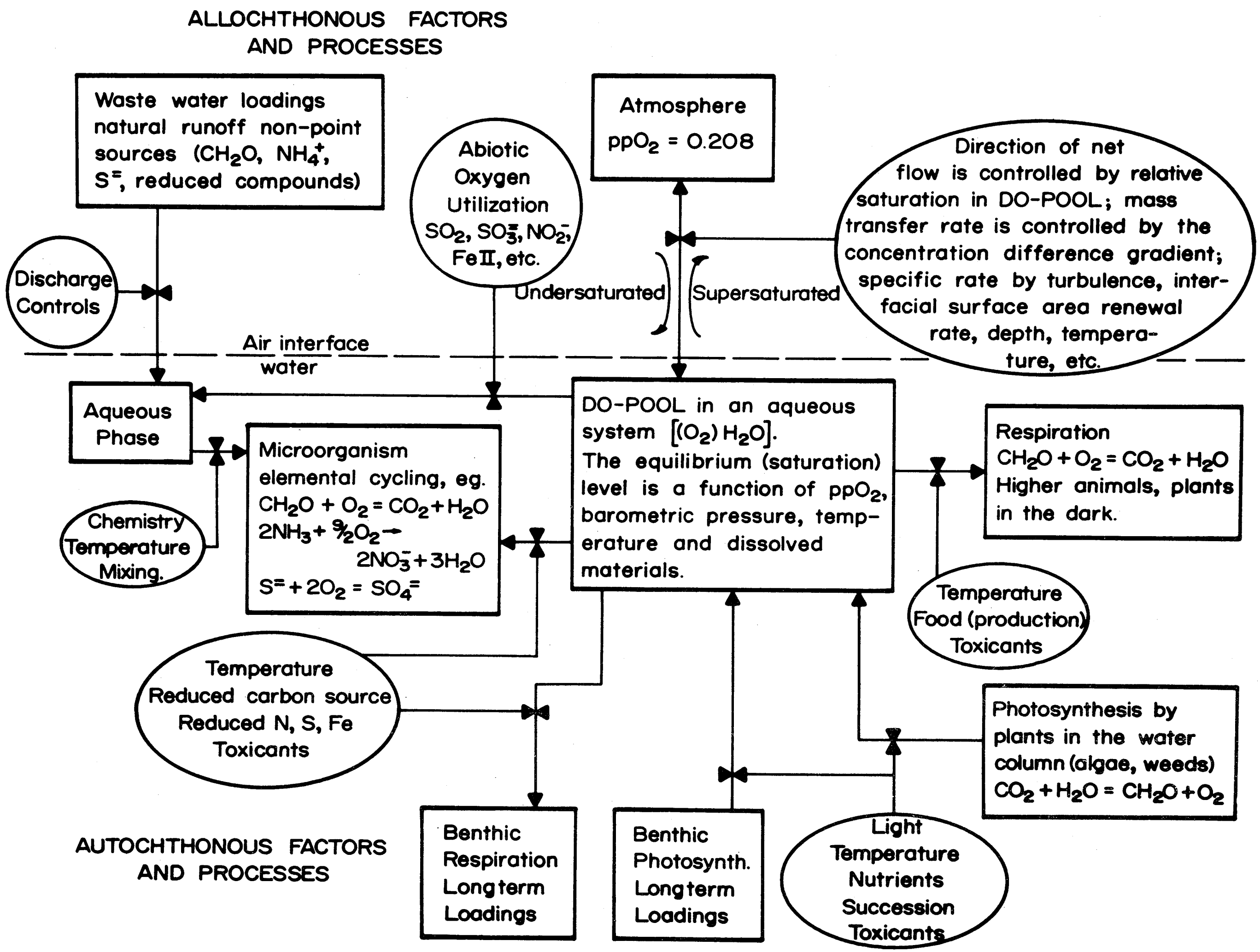

Fig. 1. Scheme illustrating the major pathways, interactions and controlling variables affecting DO levels in an aquatic ecosystem at a specific point in space, at a specific instant and with a given set of flow conditions.

In both cases flow decreases would produce the following impacts: 1) less dilution of inflows (natural and waste loads), 2) higher temperatures in the summer and thus less DO at saturation, 3) lower mass transfer rates of oxygen from the atmosphere as a result of less turbulence (depth changes would be less important in some cases such as pooling and more important in others where cross sectional area is controlled by flow), 4) changes in growth rates or types of organisms as a result of changes in typical temperature regimes, light penetration, and nutrient concentrations (loading and dilution). Increases in flow will likely result in opposite occurrences with an upper limit of effect on DO being saturation. The model allows the manager to ask these questions in a specific way and to get answers which comprehensively and interactively relate all the factors and processes which affect oxygen prior to the actual decision and follow-on physical manipulation of the real system. Then the manager can actually assess the tradeoffs which will occur as a result of further development of the water resource.

CONCLUSIONS

In reviewing the chapter on water quality parameters (Stalnaker and Arnette, 1976) we have briefly presented a summary of the approach necessary to evaluate flow change effects or determine flows for maintenance of specific water quality parameters. The time has come when we should begin to utilize the more sophisticated modeling-management process for evaluating manipulations of our environment. Because water quality modeling has reached at least an adequate level of accuracy and resolution, it is necessary that a handbook of step-by-step procedures be developed immediately for use by managers and others to evaluate the effects of stream flow alterations on specific water quality parameters.

Further evaluation and development of the quantitative interrelationships between aquatic system parameters as well as relations to flow are needed but should not prohibit the development of the handbook. Training workshops on data collection, analytical methods, model calibration and uses should follow the publication of the handbook. Instream flow management objectives need to be closely coupled with models by using the workshops to cause modelers and managers to work together.

REFERENCES

Doudoroff, P., and D. L. Shumway. 1970. Dissolved oxygen requirements of freshwater fishes. Food and Agricultural Organization Fisheries Technical Paper 86, FAO, Rome. 291 p.

NAS-NAE. 1972. Water quality criteria, 1972. Superintendent of Documents, Washington, D.C. 20402. Stock Number 5501-00520. 594 p.

Stalnaker, C. B., and J. L. Arnette (editors). 1976. Methodologies for the determination of stream resource flow requirements: an assessment. U.S. Fish and Wildlife Service, Office of Biological Sciences, Washington, D.C., 199 p.

METHODOLOGIES FOR DETERMINING INSTREAM FLOWS FOR FISH AND OTHER AQUATIC LIFE: OVERVIEW AND OUTLOOK

Joseph L. Arnette
BIO/WEST, Inc.
P.O. Box 3226
Logan, Utah 84321

ABSTRACT

This paper is presented as a summary of Section 4, Methodologies for Determining Instream Flows for Fish and Other Aquatic Life. The problems of information availability and transfer are discussed. The organization of Section 4 is described, as are the approaches to data gathering and evaluation. A discussion of methodology refinement, recommendations and research needs is presented. The paper concludes with a general discussion of the status and future of methodologies.

INTRODUCTION

There is a relatively large body of literature that is applicable to the assessment of stream flows necessary for fish, other aquatic life and the aquatic habitat. Nevertheless, of the literature reviewed in Section 4 only about 40 percent are in published or generally available form. If only refereed or intensively edited works are considered this number decreases to under 30 percent. If it is assumed that this is representative of the subject literature a large segment of recorded work is unavailable to the planner, researcher and decision maker. Exclusive of this, but possibly as extensive, is work that has not been recorded and is only available through personal communications. The following quote describes this particular deficiency (as well as the solution) in the state of the art and knowledge of stream flow assessment methodologies:

> It is inherent in any activity which is properly a 'practice'... that the practitioners know a greal deal, even though nobody has converted this into genuine 'knowledge', or made it accessible to other practitioners... And in every such 'practice', bringing together this knowledge which represents the accretion of experience over long periods, is the greatest step forward one can possibly take. This, the codification of what is already known, its systematic organization, and above all its publication, converts a mysterious craft into a teachable and learnable practice which can increasingly be founded on true, systematic knowledge. (Peter F. Drucker, in Calhoun, 1966: iv)

The problem of inadequate information transfer is now and will continue to be compounded by the multiple use demands placed on flowing aquatic systems. With these demands come multidisciplinary problems whose solutions will require an intense collaborative effort. Workers at all levels in this collaboration will be confronted with difficulties that few, because of specialized training, a lack of codified knowledge and limited information transfer, will be prepared to solve.

Section 4, as well as the entire document, was designed and written as a state-of-the-art report to provide a technical information base for involved professional groups. This information consists of a compilation and evaluation of flow assessment methodologies used by aquatic biologists, hydrologists and others involved in determining the stream flow requirements of aquatic systems and their components. The objectives of Section 4 were to provide a cross-disciplinary information source, a base for expansion (i.e., a handbook or manual of methodologies), and guidelines for methodology refinement and development.

ORGANIZATION AND DEVELOPMENT

Section 4 is divided into two major categories. The first describes approaches to preserving the aquatic and riparian habitat and the associated resources, and the second concentrates on methods for assessing the impact of altered flows on the aquatic fauna, primarily the fishes.

Methodologies for evaluating the aquatic habitat and determining flows for its preservation are, in general, directed towards the biological components of the aquatic system. These approaches are more generalized, however, and are not oriented toward any specific biological phenomenon, e.g., spawning or incubation. Some of these methodologies utilize historic records of flow (mean annual, monthly or percentages of these flows) to determine the discharge necessary to maintain the aquatic habitat and associated plant and animal life. The emphasis is on relating available data (e.g., U.S.G.S. gaging stations) to the requirements of an aquatic system, whether a river, river basin or specific hydrologic province. Methodologies were reviewed that relate measured hydraulic parameters (e.g., velocity, width, depth) at a given flow to specific habitat availability at that flow. Using the parameter/flow relationship, these approaches attempt to predict the flows necessary for a desired level of habitat retention.

Some of these approaches emphasize a random assessment while others evaluate only "critical or limiting" habitat.

The rationale for using faunal life stages to categorize particular methodologies is presented in several statements concerning Section 4:

> Most of the methodology development to the time of this writing had concentrated upon particular life stages of the salmonids. Consequently the organization of this section has been related to the reproductive (spawning), migratory (passage), food (benthic insect-riffle production) and shelter (instream, micro-habitat, cover) needs of fishes. (Stalnaker, 1976:8)

In addition,

> ...flow is, at various levels, directly related to virtually all stream parameters of significance to the life of aquatic organisms and becomes the major determinant of the activities of many species of stream dwelling organisms. (Stalnaker and Arnette, 1976:97)

Discharge determines parameters such as width, depth, wetted area and velocity levels, thereby directly, and often dramatically, affecting every life stage of aquatic fauna. In general, the approaches discussed in this category relate the physical requirements (mainly depth and velocity) of the major life stages of fishes to discharges that would satisfy these needs.

The methodologies described in Section 4 were obtained from a variety of sources; those reporting directly on the measurement and ecological effects of stream flow variation, and those indirectly related, but adaptable to flow assessment. A particular effort was made to determine state and federal agency approaches to flow evaluation and recommendation. When it was necessary and possible, interpretations of methodological descriptions were verified by individuals with intimate knowledge of the approach.

The critiques of each major subsection were presented to indicate how efficiently flow assessment approaches served the purpose or purposes for which they were designed. These critiques were originally the judgements of the authors. However, through reviews and extensive personal contacts, as the section developed, the evaluations of the methods became more representative and realistic.

In addition to the critiques, methodologies were evaluated relative to their applicability at different project levels. To facilitate this evaluation three study types were formulated. Reconnaissance studies were those limited by time and funds resulting in low resolution findings. Studies requiring on-site, but limited field measures and intensive on-site studies requiring substantial measurement were those demanding a greater commitment of time and funding, but resulting in data of high resolution. Discussing the methodologies relative to this type of study framework allowed a more realistic appraisal of their specific as well as overall utility.

One of the functions of this document was to determine the feasibility of a comprehensive methodology. This ultimately proved unrealistic for individual desciplines as well as for inter-disciplinary assessment. The recommended approach was to identify and designate criteria for sets of increasingly comprehensive methodologies suited to disciplines, planning levels and required degrees of resolution.

METHODOLOGY REFINEMENT AND RESEARCH RECOMMENDATIONS

Many of the methodologies reviewed, when not extended beyond their original design, are adequate as flow assessment tools. Nevertheless, in view of current and proposed resource development programs, with the subsequent and ever increasing aquatic ecosystem perturbations, there are important methodological areas that must be more specifically addressed. There are at present no approaches that: 1) Evaluate the magnitude and range of effects that result from incremental increases or decreases of flow through a natural stream channel, 2) assess the cumulative, long range ecological effects of permanent augmentations or reductions in flow, and 3) that will correlate the totality of effects of altered flow on an aquatic system. These areas are quite complex and there are inherent difficulties in their assessment. However, until these particular methodological deficiencies are overcome there will be a significant gap in the literature on the physical and ecological effects of manipulated stream flow.

Several of the recommendations presented in Section 4 are important enough to be mentioned again. The first is testing and validation of existing methods to allow a direct comparison of approaches utilizing similar data or addressing similar problems. It is particularly important to compare, under equivalent conditions, methodologies using historical records of flow with those employing field measured data. Second, a manual or handbook of standard methodologies for assessing flow requirements that would provide the aquatic biologist (as well as the nonbiologist) with accurate descriptions of available approaches appropriate for a range of problems. Third, and perhaps most important, an information storage and retrieval system that would provide workers in the aquatic sciences access to information that is presently difficult to obtain.

Section 4 concluded with an expanded outline of research needs fundamental to the assessment of aquatic habitat and fauna. The main point emphasized in the outline was the necessity for research that would expand the knowledge of faunal species criteria. It became increasingly evident as the section developed that possibly the major deficiency in the state-of-the-knowledge concerned flow related species criteria. This research should include "undesirable" as well as "desirable" species and should be conducted for all major life stages. It was recommended that target organisms (important fish and invertebrate species) be used for priority research and on-site stream flow requirement evaluations.

Areas of increasing importance that should be intensively investigated are the hydraulic and ecological aspects of winter regimes, particularly subsurface ice, of high mountain streams and the rivers of the northern Great Plains. Physical scientists have been involved with this problem since the early part of this century, but virtually nothing is known of the biological impacts of subsurface ice. However, cold region streams with altered, especially reduced, flows are very likely to be significantly impacted by winter conditions.

METHODOLOGIES: THE FUTURE

Two primary considerations of flow assessment methodologies were presented in Section 4. The second and most important is the role of methodologies in the broad scope of flow assessment and recommendation. A basic assumption is that ... methods are only tools to aid in achieving a desired goal and must be viewed as a means to an end, not an end in themselves. (Stalnaker and Arnette, 1976:131) In the rush of technological advance it is easy to lose sight of the basic fact that a tool is not true or false, it is simply useful or not useful for explanation or prediction. To technique oriented professions this may have the ring of heresy, but methods are often employed with less concern for their operational utility than for their availability or current level of acceptance in the professional community. Alfred North Whitehead (1925:200) has said that modern professionalism is the training of minds to conform to the methodology. This statement was made in a more general scientific context, but nevertheless has pertinence at virtually any level of consideration. Implicit in Whiteheads statement are two thoughts; that professional conformity tends to preserve a disciplines' useful methodologies, but that it also is a source of, often irrational, prejudice concerning approaches. The main point is that practioners of water management, biologists, engineers or social scientists must not allow themselves to be inhibited or restricted by personal bias or limitations inherent in their own methodologies.

In any discipline rational self criticism is an essential prerequisite to removing the barriers of conformity and effecting change. Although it is necessary and desirable to have constructive criticism from outside a particular profession, it often happens that the "outside" assessment may be found in the unconformed thinking of some of its own members. To effect significant change and to progress beyond measurement techniques and data collection, methodologies must be refined or developed objectively and very critically within a logical framework of functionality and problem resolution. However, new and difficult problems do not necessarily eliminate older, and in some cases more primitive, approaches. It seems that a balance can be achieved between certain conventional approaches and refined, sophisticated methodologies. An essential guideline for the evaluation of any methodology, old or new, simple or complex, is that it must contribute to an integrated assessment structure. It is necessary to move from fragmented, atomized approaches to those that provide functional and conceptual unity to problem solving.

Water use demands are expanding so rapidly that perhaps it is now necessary to go beyond methodological considerations and redefine the fundamental concepts of assessment. It is important that any redefinition encompass a broader scope of objectives and operations than ever before. All encompassing methodologies are not feasible, at least at this point in time, but a wider conceptual base is. Whether this is considered as a set of abstractions, a series of functional concepts, comprehensive constructs, or simply a range of scenarios, a modus operandi of alternative action is provided for planners and decision makers. If the use of methodologies is viewed as a second part of a very oversimplified three step process, planning-assessment-implementation, then it is evident that the first step is fundamental to the quality and utility of the entire process, and will provide functional guidelines for assessment approaches. No matter how sophisticated methodological procedures become, no matter how potentially efficient they are, the end result is only as good as the fundamental constructs or conceptual base.

CONCLUSIONS

The effectiveness of water management seems to rest on reaching a balance between organizational stability and cohesiveness and adaptation to rapid technological and political change. Planners, decision makers and researchers must be prepared to solve large scale problems and perhaps more realistically, to live with continuing inter-disciplinary dilemmas. Whatever the future holds is presently only conjecture. One thing, however, is certain; that those involved in water management and allocation are on the verge of facing incredibly complex and far reaching problems. Certainly, as the quantity of knowledge accumulates and the level of ability increases, many of these problems will be solved. However, this will not take place over a short period of time and will be achieved only through rational planning and inter-disciplinary cooperation.

LITERATURE CITED

Calhoun, A. (ed.) 1966. Inland fisheries management. Calif. Dept. Fish and Game. 546 p.

Stalnaker, C. B. 1976. Introduction. *In* Stalnaker, C. B. and J. L. Arnette (eds.). Methodologies for the Determination of Stream Resource Flow Requirements: An Assessment. U.S. Fish and Wildlife Service. 199 p.

Stalnaker, C. B. and J. L. Arnette. 1976. Methodologies for determining instream flows for fish and other aquatic life. *In* Stalnaker, C. B. and J. L. Arnette (eds.). Methodologies for the Determination of Stream Resource Flow Requirements: An Assessment. U.S. Fish and Wildlife Service. 199 p.

Whitehead, A. N. 1925. Science and the modern world. Lowell Lectures, 1925. New American Library. 212 p.

METHODOLOGIES FOR ASSESSING INSTREAM FLOWS FOR WILDLIFE

John A. Kadlec
Department of Wildlife Science
Utah State University
Logan, Utah 84322

ABSTRACT

Formal methodologies for determining instream flow requirements for wildlife purposes do not exist. Current and past research on the effects of water developments on wildlife suggests an approach consisting of a) inventorying existing habitats, b) hypothesizing or knowing the effect of anticipated hydrologic changes on these habitats, c) projecting the changes in habitats, and d) projecting the effects of the changes in habitats on wildlife. Research is needed on all of these steps, but "b" and "d" are most critical. The role of floods in maintaining non-channel aquatic and riparian habitats is particularly important. Studies of the relation of habitat types to hydrologic changes are fundamental. The dependence of wildlife on habitat needs much study to be useful in this context.

INTRODUCTION

Formal methodologies for determining instream flow requirements for wildlife purposes do not exist. This is true at least in the sense of, for example, the "Oregon method" for fishery considerations.

Arguing from the basic ideas of wildlife science, one can postulate at least four classes of effects of altering natural water flow regimes: a) Removal of drinking water for terrestrial birds and mammals (not all require it); b) Altered flow patterns or volumes may directly affect aquatic wildlife such as beaver or muskrat; c) Lowered water tables may alter riparian vegetation, eliminating essential elements of habitat for some species; d) Changed patterns of flooding may affect wetland habitats such as willows and marshes which depend on flood waters for their maintenance. Only the first two of these are direct; yet they are not likely to be of major importance unless the flow is stopped completely. Some potentially important effects include the possible benefit to beaver, muskrat, and waterfowl of reduced flood peaks. Alternately, very low minimum flows might be inadequate to compensate for increased evaporation from ponds and thus be detrimental to beaver.

Most serious effects are likely to be from changed hydrologic and hydraulic regimes, including groundwater, and the resultant effects on vegetation and habitat. The importance of riparian vegetation for wildlife is well known and well documented. It is particularly critical for wildlife in arid to semi-arid regions (Oliver, 1974; Carothers and Johnson, 1975). In a sense, one might consider wildlife a third-order response variable to changed flows; hydrologic changes are first order, vegetation changes second order. Methodologies to specify required flow regimes for wildlife therefore depend on understanding the complex cause-effect chain.

In this paper, wildlife is defined as birds and mammals, although much of the discussion would also apply to reptiles and amphibians. Four functional groups of wildlife, based on the anticipated effects of altering stream flows are postulated: a) Aquatic - totally dependent on aquatic environment; examples include the water ouzel, muskrat, beaver, waterfowl, some shorebirds and herons. b) Riparian - strongly dependent on instream flow or riparian vegetation; examples include moose, otter, mink, many small birds, shorebirds and herons. c) Associated terrestrial - abundance often strongly influenced by presence of aquatic or wetland ecosystems; examples include skunk, deer, pheasants, and mourning doves. d) Terrestrial - little affected; examples include elk, bison, bighorn sheep, jackrabbits, coyotes, many small mammals. Most of the discussion will concentrate on the first two groups.

METHODS USED IN ASSESSING WILDLIFE IMPACTS OF WATER RESOURCE AND OTHER DEVELOPMENTS

Wildlife studies by and large have concentrated on the areas to be inundated by large water development projects (i.e. Oliver, 1974). Studies concerning riparian vegetation have been either of cultural effects (Burbank, 1972; Russell, 1966) or of total diversion (Carothers and Johnson, 1975), but a few studies of flow alterations are now underway.[1,2,3]

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[1] Personal communication. 1975. R. Ohmart. Ariz. State Univ., Tempe, Arizona.

[2] Personal communication. 1975. R. Martinka. Montana Fish and Game Dept., Miles City, Montana.

[3] Personal communication. 1975. J. Howerton. Wash. Dept. of Game, Olympia, Wash.

Assessment of change in wildlife resources as a result of water resource developments generally falls in three categories: a) Assessment based on hydrologic changes (Oliver, 1974; Leopold and Leonard, 1966). b) Assessment based on changes in amount or quality of riparian vegetation (Burbank, 1972; Russell, 1966; Carothers and Johnson, 1975; Bovee, 1974). c) Assessment based on area affected or animal "units" lost or imperiled (Metzgar and Wharton, 1968; Barstow, 1971; Oliver, 1974).

The general approach used in these studies might be modified for instream flow purposes. One could hypothesize some hydrologic change and consequent effects on various habitat types. The existing habitat types could be inventoried (i.e., air photos, ground mapping, etc.) and changes projected based on the anticipated effects. One could then either assume a proportional change in wildlife or, based on some rule, make weighted estimates. All elements of this procedure exist in the various reports cited. The extension to instream flow requirements has not been made to my knowledge. In principle, however, one could hypothesize a whole series of flow regimes, project their effects on wildlife, and present those data as a basis for decision-making.

On a purely hypothetical basis, one might project four kinds of relationships shown in Fig. 1. In situations A, C, and D there is no biological criterion for specifying a flow unless one first decides, on other grounds, what population is desired. In B, a biological optimum exists, but even then a selection of an acceptable minimum or maximum is contingent on an external decision. In multiple species situations, one might expect whole families of curves and mixtures of the four types, complicating the decision process. A special case of all four graphs exists where the slope of the line over the range of possible flows is 0; i.e., the line is horizontal or nearly so, and there is no detectable effect on wildlife populations as a result of alteration.

The approach suggested above is quite similar to the habitat based approaches to instream flow requirements for fish. At least two differences are important: (a) Wildlife is dependent, in many cases, on non-affected as well as affected areas, making the relationship between habitat change and population change non-linear, and (b) The recognition that, in many cases, externally set requirements for wildlife will, in effect, set requirements for instream flow.

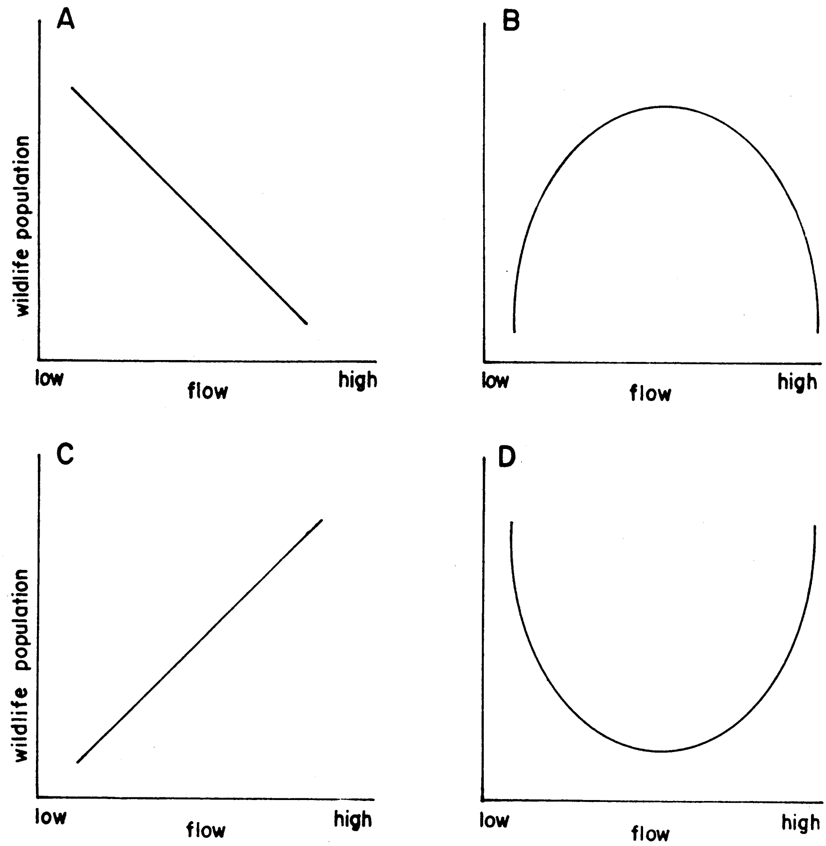

Fig. 1. Generalized Relationships Between Flow and Wildlife Populations

CURRENT RESEARCH

Several studies are currently in progress to evaluate the effects of altered flows on wildlife. In Arizona, Robert Ohmart (pers. comm.) and colleagues are studying both birds and mammals associated with riparian vegetation along the Colorado River. The study is basically a before and after approach, but the ultimate objective is the construction of models having predictive capability. Approximately 1 1/2 years of baseline data are in hand.

Along the Snake and Columbia Rivers, another group is studying the effects of daily variations in flows due to fluctuating use for hydropower peaking (Jack Howerton, pers. comm.). The first phase of the study is an inventory of habitats and wildlife conducted by the Oregon, Washington, and Idaho Cooperative Research Units. Phase II is in the design stage and will be directed at determining changes in vegetation and the resulting effect on wildlife.

In Montana, effects on furbearers and waterfowl of reduced altered flows in the Yellowstone River are being studied (Robert Martinka, pers. comm.). Beaver cache sites and goose nest sites are being evaluated in terms of the river characteristics where they exist. From this, the objective is to derive specifications for river flow patterns needed for these species. An historic approach is also being used to evaluate habitat change by comparing recent air photos with others taken in the 1930's.

A series of studies of goose nesting on the South Fork of the Snake River in Idaho correlated success with patterns of flow (Merrill and Bizeau, 1972; Parker, 1973 and 1975). The conclusion at this point in time is "that high steady spring releases (above 8,000 cfs) from Palisades Dam will provide the maximum amount of goose nesting habitat and will probably result in high numbers of goslings produced on the South Fork" (Parker, 1975).

In each of the foregoing, it is possible to recognize elements of the habitat-based approach suggested as modification of the water development assessment procedures. In several, flow or river characteristics necessary for certain species or habitats are considered. These are important links in the knowledge needed to provide input to instream flow decision. Inventories are basically a first step in all cases. Habitat requirements for one or more species are also under investigation. The Snake River goose studies are outstanding in having been carried to the point of specifying flows.

NEEDED RESEARCH

One might sum up the foregoing by reiterating the opening statement on wildlife "Formal methodologies for determining instream flow requirements for wildlife purposes do not exist." A de facto method does exist, however, which is to gather whatever information possible on habitats and wildlife and then rely on the judgment of a trained wildlife biologist. For many purposes this may be adequate.

Where more definitive data are required, two strategies appear possible. One may either take into account the water flow regime → vegetation → wildlife causal chain or attempt to correlate wildlife and water regime empirically. Either approach implies a detailed inventory and the existence of studies which have established the appropriate set of relationships. Empirical relationships between wildlife and flow regimes require studies of nearly every species vs. flow regime combination. This background data basically requires before and after studies of either controlled (experimental) or uncontrolled situations. In time, a body of "rules of thumb" might emerge sufficient to guide flow decisions. However, there is no guarantee that results or recommendations for different wildlife species would not contradict each other.

One possible approach to the complexity of the relationship between wildlife and instream flows is the use of indicator species. In terms of the groups of wildlife proposed earlier, some of the aquatic and riparian species might have potential as indicators of the adequacy of instream flows. Even some of these, such as the moose, may lag in their response to changed instream flows so much as to be valueless as an indicator. Species with very large ranges, such as the osprey, may not respond to an alteration in only one part of their habitat. Less mobile and shorter lived species such as the muskrat, water ouzel, and breeding populations of small birds may prove to be of some value as indicators.

A general concern in use of wildlife as indicators is the normal variability of populations. For many species, annual variations in numbers due to natural causes are far greater than the anticipated impact of a reduction in instream flow.

There is of course, one case in which a change in flow is going to have predictable consequences; a total diversion, so the flow goes to zero. The obvious effect will be an elimination of the aquatic wildlife. If the diversion is truly total, in time the riparian vegetation will also disappear, and with it the riparian wildlife. But if there is some seasonal flow, or some subterranean flow or accretion, a distinct vegetation zone may be maintained, and with it wildlife.

Even in the simple case in the preceeding paragraph it is clear that the key to understanding lies in knowing first how the vegetation will respond to flow changes. This then can be coupled with a knowledge of wildlife response to vegetation change. Such a two-step procedure seems to have more inherent potential for generalizing to a wide variety of situations.

As a general approach, consider the following:

$$Y = f(X_1, X_2, X_3, \ldots, X_n) \qquad (1)$$

and

$$X_i = f_i\ (Q) \qquad (2)$$

where Y = wildlife population or population of interest, the X_i = habitat variables and Q describes the annual pattern of flows. The two equations merely formalize the two step procedure envisioned above. In the simplest case

$$Y = aX \qquad (3)$$

$$X = bQ$$

$$\text{and } Y = abQ \qquad (4)$$

That is, the population is linearly dependent on a single critical limiting habitat variable which in turn is linearly dependent on the flow. Examples of direct dependence of populations on a single variable are not rare; in some situations, wood duck populations are directly related to the availability of suitable nest sites. In few, if any, cases are the habitat variables directly a function of Q - clearly not in the wood duck example. Unfortunately, in most cases there are many X's and the relationships are non-linear. In these instances, we often have only the crudest guesses about the effects on the population of varying an X. Further, the f_i relating X_i to Q are also not well known. Yet that would appear to be the kinds of information needed for instream flow recommendations.

In mathematical terms, the foregoing equations can be combined:

$$Y = f\ (Q) \qquad (5)$$

Unfortunately, it appears that the functional relationship in this case is often very complex and would require an enormous data base to specify adequately. I am not at all sure this is a viable approach for any species.

The foregoing suggests three areas of research needs in the relationship of instream flows to wildlife: 1) Direct relationships, if they exist, for the response of aquatic wildlife to various alterations in flow regimes; 2) relationships of plant communities to changes in flows, including riparian, floodplain, marshes, deltas, etc.; and 3) relationships of wildlife to the vegetation changes.

In each of these research areas, there are likely to be significant variations with latitude, altitude, hydrologic regime, geological setting and a host of other factors. These are generally reasonably well integrated by the terrestrial ecological system. It has been suggested (Instream Flow Workshop, Utah State University, 1975) that some approach similar to Merriam's Life Zones might be used to stratify information and the general ecological setting. If one further sub-divides the wildlife into a series of groups, as suggested earlier, then the cross-classification might produce classes sufficiently homogeneous to permit generalization.

Within this general framework several areas of research seem to me to be especially critical. First, it seems likely that flows adequate to maintain fishery values are also adequate to maintain instream wildlife such as the water ouzel or beaver. However, an approach based strictly on fish considerations may not be satisfactory for maintaining non-channel habitats important for wildlife - notably marshes and riparian vegetation. Therefore, there is an important need to summarize what is known about the relation of flows to such habitats and to begin field research on important habitats. Basically, this means a concerted effort to relate hydrologic and hydraulic changes to the vegetation. It seems quite likely that frequent flooding is essential to maintain these habitats, whereas the same level of flooding may or may not be of importance to fish.

There is surprisingly little information available to predict wildlife abundance from a knowledge of vegetation. General habitat requirements are known, of course, but what is needed is the ability to predict a change in a species population from a specified change in habitat - at least semi-quantitatively. It does not seem practical to begin to develop this kind of information for all species - some selection must be made. One possible approach would be to consider rare, endangered, or threatened species first; then exploited species assuming the additional threat to their numbers via habitat change may be crucial; and then a selection of variety of other species which may be of value as indicators of habitats requiring specific instream flows.

Studies of well-known species designed to capitalize on existing knowledge by organizing, refining, and supplementing it with minimal field study would provide usable information rapidly. However, critical species, even if poorly known, would demand attention first. Using these priorities, there is some hazard that a critical species might be overlooked, but with limited resources that is a risk that must be taken.

LITERATURE CITED

Barstow, C. J. 1971. Impact of channelization on wetland habitat in the Obion-Forked Deer Basin, Tenn. Trans. 36th NAW & NR Conf. pp. 362-373.

Bovee, Ken D. 1974. The determination, assessment, and design of "In-stream Value" studies for the northern Great Plains region. Final report to EPA.

Burbank, J. H. 1972. A quick method to assess streamside wood duck breeding habitat. Proc. 26th An. Conf. S. E. Assoc. of Game and Fish Comm. pp. 205-206.

Carothers, Steven W. and R. Roy Johnson. 1975. Water management practices and their effects on nongame birds in range habitats. pp. 210-222 in Proceedings of the Symposium on Management of Forest and Range Habitats for Nongame Birds, Tucson, Arizona, May 6-9, 1975. USDA Forest Service General Technical Report WO-1.

Leopold, A. Starker and Justin W. Leonard. 1966. Effects of the proposed Rampart Dam on wildlife and fisheries. Trans. 31st North American Wildlife Conference. pp. 454-459.

Merrill, Lynn B. and Elwood G. Bizeau. 1972. Canada goose production as related to stream flow on the South Fork of the Snake River in Idaho: A preliminary survey. Idaho Coop. Wildl. Research Unit, Moscow, Idaho. 39 p.

Oliver, Wendell H. 1974. Wildlife problems associated with hydro-power reservoirs. Bull. No. 3, Washington Dept. of Game, Olympia. 10 p.

Parker, Thomas L. 1973. South Fork Canada goose study (1973). Unpub. Idaho Fish and Game Department Report. 31 p.

Parker, Tom. 1975. Survey of Canada goose nesting on the South Fork of the Snake River, Idaho. Unpub. Idaho Fish and Game Dept. Rep. 10 p.

Russell, D. M. 1966. A survey of streambank wildlife habitat. 20th S.E. Assoc. of Game and Fish Commissioners. pp. 37-41.

Stalnaker, C. B., and J. L. Arnette. 1976. Methodologies for the determination of stream resource flow requirements: an assessment. U.S. Fish and Wildlife Service. 197 p.

Metzgar, R. G., and D. A. Wharton. 1968. Planning the management of Maryland wetlands. Proc. 22nd Annu. Conf. S.E. Assoc. of Game and Fish Comm. pp. 68-82.

ASSESSMENT OF RECREATION AND AESTHETIC STREAM FLOW METHODOLOGIES

Wade H. Andrews and Gary E. Madsen[1]
Institute For Social Science Research
On Natural Resources
Utah State University
Logan, UT 84322

ABSTRACT

Changes in stream flows effect the quality and form of human use of streams. In order to understand the effects of these changes it is necessary to develop methods of measurement. In reviewing the methodology for human behavioral measurement almost no social science methods had been developed directly for streamflow analysis. However several techniques were found to be applicable and are promising for adaptation to the problems of recreation and aesthetic measurement. There is a need to both develop and test techniques and to apply them to the problem of stream flows.

INTRODUCTION

The Problem

Resource managers who have multiple-use objectives must provide an appropriate mix of recreational and aesthetic opportunities that will serve as great a percentage of the public as possible. This requires comprehensive information on actual and potential resource conditions, ecological and social constraints, demographic characteristics, user and manager attitudes and interests. The managers also need to know the attributes of streams that users consider important. They can gather this information by observing, measuring, and quantifying the existing recreational participation and aesthetic interest patterns.

Why Measure Recreation and Aesthetic Interest

The justification for measuring recreational and aesthetic opportunities is that they are increasingly important public concerns. Ecological and aesthetic concerns are linked because both indicate an interest in nature, and because often the most discernible ecological effects are those that

[1] This paper draws directly from the material in Chapters 6 and 7 in the report edited by Clair B. Stalnaker and Joseph L. Arnette titled, "Methodologies For the Determination of Stream Resource Flow Requirements: An Assessment."

alter the aesthetic qualities of a natural resource. This has led to directives to public agencies (NEPA, particularly Sec. 102C) to include social considerations in calculations of effects on and worth of natural resources (including aesthetic and recreational parameters). In order to do this, the important social factors must be measured in comparable and meaningful ways.

There is a practical side to these considerations. With increased public attention to scenic beauty and recreation experience, proposed resource allotments are often being challenged on the basis of aesthetic and recreational deficiencies. Such proposals can be implemented or avoided and contentions resolved by more than opinions, only if valid data are available.

While the literature on recreation in general is voluminous, that for aesthetics is limited, and research relating changes in recreation and aesthetic behavior to changes in stream environments is almost nonexistent.

THEORETICAL CONCEPTS

Defining Recreation and Aesthetics

Lerner (1962) describes recreation as voluntary activity engaged in by man over and above that required for broad needs. If these elements are accepted, all nonsustenance activities related to the environment along streams may be included under recreation.

The activities listed below typify, but are not limited to, nonsustenance-type behaviors that are related to streams: 1) Instream Recreation - fishing, swimming, wading, boating, (power, kayacks, canoes, etc.) floating (rafts, tubes), water skiing, scuba diving, water fowl hunting; 2) Recreation Adjacent to Streams - picnicking, camping, hiking or walking, driving, viewing, collecting rocks, observing fauna and flora. Participation in some of these activities depends, to some extent, on an appreciation of the aesthetic aspects of streams.

As to aesthetics, the literature indicates that the major focus of studies in environmental aesthetics to date has been to identify and define scenic beauty. General scenic beauty and streamflow aesthetics are assumed to be related. The focus of the latter is narrower, however, so the variety of parameters involved in aesthetic perception may also narrow and thus simplify analyses. But the precise identification of the few pertinent aesthetic factors associated with streamflows become highly important.

Aesthetics and recreation are correlated[2] because both provide pleasure, and a recreation activity may be undertaken to achieve an aesthetically pleasurable sensation. They have generally been distinguished in the literature by the recreation activity giving pleasure per se while the aesthetic object provides sensory pleasure.

The attempt to distinguish between recreation and aesthetics provides a partial basis for differences in the types of methods available to measure recreation as opposed to aesthetics. Since recreation theoretically involves activity as the central focus, it involves measurable and obtainable figures, such as those involving use and expenditure of resources. Consequently, in addition to sociological and social-psychological methods, economic evaluation methodologies have been applied. Aesthetics, however, since it involves a sensitivity or emotional evaluation and not necessarily activity, has been investigated more by psychological methods. Further conceptualization and critiques are needed to bring about additional improvement in the theoretical component of this work.

Differences in their theoretical constructs would seem to require separate treatments for recreation and aesthetics, although there are important similarities in some techniques. For example, subjective evaluations such as attitudinal scaling techniques have been used for both recreational and aesthetics factors.

RECREATION METHODS

A review of recreation methods shows that approaches for specifically assessing recreation-streamflow relationships have not been developed. However, several techniques have appeared that can be applied to this type of assessment.

Stream classification and categorization techniques, although not technically social behavioral methods, are useful as basic data. These are techniques which classify streams as to what it is physically like, what its parameters are, what recreation activity is possible or what the stream is used for. These methods include such as those of Leopold and Kinnison which was further developed in Craighead (1972) and of Wolf Bauer as presented by Morris (1974). Such standard typologies will assist in the need for standardized tools for use in stream flow studies.

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[2] This correlation has been verified. See Andrews et. al., 1972, and Andrews, et. al., 1974.

It would be useful if a standard method of stream classification were agreed upon and applied on a nationwide basis. Present methodologies reviewed, however, were based mainly on subjective judgments and therefore subject to judgmental error. This problem would limit them largely to local application.

Rating techniques have been used by several people to judge the adequacy of streams for recreation. These use methods involving judges. One of these, the Thompson-Fletcher (1972) model for determining the quality of a recreational activity under varying conditions, seems to be adaptable to streamflow assessment. This model does not categorize streams, but establishes numerical values for conditions of water bodies in relation to specific categories of activities. However, as designed, these values depend upon the use of experts as judges. Adaptation of the model to use public values must be made. Other methods in this category are team rating, rating of wild and scenic rivers and those used by Jaakson, Bishop and Welsh and Crouch in Bayha's (1974) report, "Anatomy of A River."

Assessment of public behavior approaches involve assessment of demands and analyses of social values and attitudes relating to recreation. These problems include: what is the public involvement, and user satisfaction and opinion. Survey methods and attitude scaling methods are applied to these problems. Also these methods may be used to determine changes in characteristics of users and use patterns.

Other techniques that would be useful are modeling procedures and longitudinal analysis. (These are discussed further in Andrews, et. al., 1976.)

For planning within an agency, social modeling methods are being developed that can be useful for predictive or projective purposes. Modeling is useful in analyzing decision and action processes. In addition, it can have an important role in simulation of solutions to provide either insight or predictability for planning. Considerable research and development and substantial testing would be necessary for adapting these models to the streamflow problem.

The modeling method may be combined in limited situations with the Delphi method which is a means for determining a consensus of priorities through the use of a limited number of experts. The Delphi method and derivations of this technique will also provide a useful means to identify and analyze variables required in decision-making and problem resolution on several study levels.

A longitudinal analysis or observation over a period of time of human behavior related to streamflows is a useful method to determine the effects of changes in streamflow on recreation. Longitudinal post-factum studies of the relationship between streamflow variations and changes in recreation behavior may be used. One approach would be to use secondary data by which investigations would seek out stream situations where the streamflow has been altered in the past and then reconstruct changes in recreation behavior from the secondary data.

Suggested Research Stages For Research

In reviewing the state-of-the-art, it became apparent that there were several steps or stages that could be identified in the process of bringing this work to direct application to instream flow recreation problems.

1. Identify and classify recreation parameters that are affected by variations in streamflow levels. The parameters at this stage in the research development must refer primarily to differences in streams. The classification methods would involve the selection and further research and refinement of one of the methods.

2. Classify streams at various flow levels according to the potential for various recreation activities. This stage in the research development would require the selection and then research and modification of one of the methods outlined in the second part of this section.

3. Utilize comparative longitudinal method techniques to study specific locations throughout the country where streamflow changes have occurred to determine changes in recreation behavior. Secondary data records along with local information would be the research tools.

4. Develop methods to establish relationships between streamflow changes and satisfaction with the recreation experience. Examples of techniques would include ratio scales, and other attitude scales such as Likert, semantic differential and quasi-scales.

5. Measure perceptions and behavior of the public in relation to specific streamflow situations. This stage would involve on-site analysis of various recreation populations.

6. Develop and/or adapt techniques designed to establish relationships between streamflow modification and recreational behavior and satisfaction levels, in order to evaluate the effects of variations of streamflow on human behavior or human needs or desires.

7. Designate indicators of the effect of changes of streamflow on recreation activity and aesthetic states under specific conditions. This could result from application of the suggested research.

8. Develop equation or other methods for prediction of the probable type of recreation behavior related to streamflow and the aesthetic evaluations of different streamflow conditions.

9. Develop simulation models for future planning and management decisions.

APPROACHES TO AESTHETIC MEASUREMENT

In relation to aesthetic assessment many of the social science measurement methods were designed to measure traits and patterns of individual and collective behavior, not properties or qualities of environments. Important conceptual and methodological differences in the use and interpretation of these measures therefore depend upon which application is involved. Both the individual's behavior or response and the physical elements in the environment he responds to may be measured.

Within the behavioral aspect Daniel, et al., (1973 have classified the problems of measuring as involving: 1) The person's sensory experience relevant to the perceptual dimension that defines the judged characteristic: and 2) the person's willingness to make discriminations at each point on the given dimension. They called these two elements, respectively, the observer's criteria and his sensitivity. This seems to be a valuable way of conceptualizing these two variables.

An example of the physical elements approach is illustrated in a three step analysis (Masteller, et. al., 1976). The purpose of this three stage identification is to provide a standard, more specific to streamflow aesthetics, by which the methods may be evaluated and to which research needs may be related.

I. The first step in determining relationships between streamflow and aesthetics involves a documentation of actual changes in the streamflow utilizing: (a) A classification of streamflow types, a combination of water, shoreline, and interface factors; (b) A systematic recording and description of changes which take place with known quantitative changes in flow.

II. The next step is to determine which of the water, shoreline, and interface factors identified as potential components of the aesthetic experience are actually seen at different streamflow levels, at what level of discrimination, in what interrelationships, and with what degree of importance.

III. Given I and II, the next step is to ascertain the aesthetic role, if any of each perceived element and of combinations of elements, and their relationships to streamflow.

The first two steps relate to physical elements. The primary approach for this third step would be user evaluation analyses. The literature shows a wide usage of judgments of professional experts in regard to this problem. It is not known whether interdisciplinary, interagency professional evaluations differ from those of the general public. These evaluations as methods are also area specific and must be placed in the perspective of more general application.

Several methodologies are useful for aesthetic measurement. The techniques of attitude scaling for measuring social values and attitudes is one of the principle approaches which may be used. Methods already developed of this type include: 1) Rating techniques such as ordinal scales with a numerical range of responses, (Andrews, et. al., 1974, and Miller, 1970); 2) Likert scales and summated score scales, (Andrews, et. al., 1972 and 1974); 3) Guttman and quasi Guttman or unidimensional scales, (Miller, 1970); 4) Latent structure analysis, (Stouffer, 1973 and Miller, 1970); 5) Semantic differential a bi-polar rating technique, (Meredith and Ewing, 1969 and Craik, 1972); 7) Paired comparisons, (Peterson and Newman, 1969 and Jackson, 1972); 8) Comrey Method and General Allocation Techniques, point allocation methods, (Comrey, 1950 and Metfessel, 1947 and Gum, 1974); 9) Ratio scaling which rates an item as proportionally better or worse than a given standard, (Stevens, 1966 and Hamblin, 1974); 10) Scenic Beauty Estimation provides an interval level measurement, (Daniel and Boster, 1975; Swets et. al., 1961 and Daniel et. al., 1973). These are methods to identify social values, measure their strength and importance and indicate priorities.

No scaling methodologies have been applied specifically to changes in aesthetic perception as related to changes in streamflow. Some assessments have been made of particular rivers (Michaelson, 1974), but the methods employed have not been further developed and do not, in their present form, meet standards desirable for general applicability.

The second category is that of Classification Methods: 1) the Litton method, (Litton, 1968 and 1971); and 2) the Leopold systems. Direct applications to streamflow are meager although Leopold's (1969b) classification system was developed specifically for stream systems to measure the impact of a project or activity or an area. Leopold's method is probably the most commonly used. However, it has been criticized, as have others of this type, as being too judgmental and requiring the on-site presence of experts of one kind or another.

Litton developed a non-quantitative classification method which evaluated three units including "landscape" as a generalized impression, "setting" as the interaction between water and landscape and the "waterscape" itself according to whether they are enhancing, degrading or being compatible. This was developed to provide decision-makers with information that shows how man-made facilities effect the landscape.

Third, there are some other types of methods that may be useful including: 1) a social indicator technique involving the Batelle system of environmental impacts, (Batelle, 1972); and the Techcom system of disaggregation of social goals and goal indicators, (Techcom, 1974); and 2) the Landscape Preference Model (Shafer and Mietz, 1970).

General Stages of Development and Research Problems for Aesthetics

The following are stages of development that are required to bring the aesthetics measurement techniques to the stage of application to the effects of changes in streamflow levels. These also identify, in some order of priority roughly parallel to the stages, a series of research problems or problem areas associated with streamflow variations.

1. Identify, classify, and refine aesthetic and recreation parameters that are affected by variations of streamflow levels. The parameters must be connected to effects of decreased or augmented streamflow.

2. Test and examine the identified parameters separately and in relation to each other on various publics in order to determine those elements which actually are affecting the publics.

3. Develop and test methods and indicators to establish relationships between streamflow changes and recreational and aesthetic parameters.

4. Measure perceptions and behaviors of publics in relation to specific streamflow situations.

5. Develop equations or other methods for aesthetic evaluations of different streamflow conditions and the probable types of recreation behavior related to each streamflow.

6. Develop environmental simulation techniques to provide laboratory designs for studying on-going and complete environmental situations associated with aesthetics.

7. Analyze socialization and other aspects of social psychological development that creates aesthetic responses.

8. Determine the importance of aesthetic experiences in the natural environment as they affect interest and behavior relating to streamflow. Are they decreasing, staying the same, or increasing.

9. Analyze the aesthetic evaluations of professionals and the general public to determine the real difference using broad sampling techniques.

10. Study the importance of aesthetics to resource decision-making and the effects of aesthetic parameters on decision-making.

11. Develop additional approaches and methodologies which may be useful in the search for the determination of effects of changing streamflow on aesthetics.

CONCLUSIONS

In surveying the methodologies for human behavioral research related to recreational and aesthetic streamflow behavior it is evident that there are several useful techniques and several general methods that are applicable. However, few have been directly applied. What is now required is to get on with the studies that need to be done and with the known methods develop adaptations that are necessary as well as developing any new approaches that will be useful.

In doing so it should be recognized that methodological development will be a part of the research work and should be carefully done and the requisite experimentation needs to be planned for and performed. Some types of methods will require more lead time and should be carefully designed and developed. Much of this, however, can be done right along with the needed research and will not require long delays in moving the work forward.

Many of the techniques used at the present time in this work have been directed toward identifying parameters as seen by experts and ratings by experts of adequacy levels. These are primarily supply models. Although these are useful it is time to go beyond these into more systematic analysis relating to wider representations of populations and users. It would be useful, for example, to know more about public behavior, what people do when changes occur, why people make recreation choices, how the reasons for these choices relate to the resources, their willingness to accept the experts ideas, do they see things the same way as the experts, and other factors that relate to recreational and aesthetic behavior pertaining to streamflows.

REFERENCES

Andrews, W.H., A.B. Davis, K.S. Lyon, G.E. Madsen, R.W. Roskelley and B.L. Brower, 1972. Identifications and measurement of quality of life elements for water resources development: An exploratory study. Res. Rep. No. 2 Inst. Soc. Scie. Res. Nat. Resour., Utah State Univ., Logan, Utah

Andrews, W.H., G.E. Madsen and G.J. Legaz 1974. Social impacts of water resource developments and their implications for urban and rural development: A post-audit analysis of the Weber Basin Project in Utah. Res. Monogr. No. 4, Inst. for Soc. Scie. Res. on Natur. Resour., Utah State Univ., Logan, Utah

Andrews, W.H., M.B. Masteller, J.P. Riley and E.K. Israelsen. 1975 Methodology and application--Modeling the total hydrologic-sociologic system of an urban area. Inst. for Soc. Scie. Res. on Natur. Resour. and Utah Water Res. Lab. Utah State Univ., Logan, Utah.

Andrews, W.H., J.P. Riley, C.W. Colton, G.B. Shih and M.B. Masteller. 1973. A preliminary model of the hydrologic-sociological flow systems of an urban area. PRWG 109-1. Utah Water Res. Lab., Utah State Univ., Logan, Utah.

Andrews, W.H., M.B. Masteller, D.E. Massey, R.B. Burdge and G.E. Madsen, "Measuring the Impact of Changing Stream Flow in Recreation Activity", C.B. Stalnaker and J.L. Arnette (eds.) in Methodologies for the determination of stream resource flow requirements: an assessment. U.S. Fish and Wildlife Service, 1975. 55 p. (Chapter 6)

Appleyard, D.K. Lynch, and J. Myer 1965. The view from the road. MIT Press.

Arthur, L.M. 1975. Testing the predictive utility of scenic beauty estimation technique. Unpub. Ph.D. Thesis, Univ. of Arizona, Tucson, Arizona.

Arthur, L.M., T.C. Daniel and R.S. Boster. 1975. Scenic beauty assessment: A literature review. Rocky Mountain Forest and Range Exper. Station USFS, Fort Collins, Colorado. In Press.

Battelle. 1972. An environmental evaluation system (EES) for Water Resour. Planning. Battelle, Columbus Lab. Columbus, Ohio.

Bayha, K. (ed) 1974. Anatomy of a river: Report of the Hells Canyon Task Force. Pacific N.W. River Basin Comm. 203p.

Bishop, A. 1972. An alternative evaluation matrix. Instream Flow Methodology Workshop, Olympia, Washington, November, 1972.

Boster, R.S. 1974. On the criterion and the possibility of quantifying the aesthetics affects of water resources projects. In Brown, P.J.(ed.). Toward a technique for quantifying aesthetics quality of water resources. IWR Contract Rep. 74-8.

Boster, R.S. and T.C. Daniel 1972. Measuring public response to vegetative management. In proceedings 16th Annual Arizona Watershed Symposium. Watershed management effect on wildlife and recreation, Arizona Water Comm. and the Arizona Water Resour. Commit., Phoenix, Arizona.

Brewer, D., and G.A. Gillespie 1967. Estimating satisfaction levels of outdoor recreationists, J. Soil and Water Conserv. 22:67.

Burdge, R.J., and D.R. Field. 1972. Methodological perspectives for the study of outdoor recreation. J. Leisure Res. 4:63-72.

Burdge, R.J., and S. Johnson. 1975. Assessing the social component of environmental impact statements. In McEvog, J. III, (ed). Social impact analysis. John Wiley & Sons, New York.

Calvin, J.A. and J.A. Dearinger 1972. An Attempt at assessing preferences for natural landscapes. Environment and Behavior, 1(1):7-35.

Comrey, L. 1950. A proposed method for absolute ratio scaling. Psychometrica. 15(3): 317-325.

Craighead, F. 1962. River systems; recreation classification, inventory and evaluation, Naturalist 13(2).

Craik, K.H. 1971. The assessment of places. In McReynolds, P. (ed.). Advances in psychological assessment. Science and Behavior Books, Palo Alto, Calif. pp. 40-62.

Craik, L.H. 1972. Appraising the objectivity of landscape dimensions, In Krutilla, J.V. (ed.). Natural environments: Studies in theoretical and applied analysis. Resources for the Future, Inc. John Hopkins Univ. Press, Baltimore, Maryland.

Daniel, T.C., and R.S. Boster. 1975 Measuring scenic beauty: The scenic beauty estimation method. Rocky Mountain Forest and Range Exper. Station USFS, Fort Collins, Colorado. In Press

Daniel, T.G., L. Wheeler, R.S. Boster and P.R. Best Jr. 1973. Qualitative evaluation of landscapes: An application of signal detection analysis to forest management alternatives, Man and Environ. Systems. 3(5):330-344.

Davis, L. 1974. Quantifications of connectives for the recreation goal of Techcom. In Water resources planning social goals and indicators: Methodological development and empirical test. PRWG 131-1, Utah Water Res. Lab., Utah State Univ., Logan, Utah.

Fabos, J.G. 1971. An analysis of environmental quality ranking systems, In Recreation Symp. Proc. Northeastern Forest Exper. Station. USFS, Upper Derby, Pa. pp. 40-55.

Guilford, J.P. 1954. Psychometric methods, 2nd ed. McGraw-Hill New York, N.Y.

Gum, R.L. 1974. Identification weights and measurement of social goals. In Techcom, 1974. Water resources planning, social goals and indicators: Methodological development and empirical test. PRWG 131-1, Utah Water Res. Lab., Utah State Univ., Logan, Utah.

Gum, R.L., R. Hedge, D. Kimball, and W. Wilson. 1974. Quantifying aesthetics opportunity. In Brown P. J. (ed.) Toward a technique for quantifying aesthetic quality of water resources. Utah State Univ. Logan, Utah.

Guttman, L. 1948. Chapters 3-9. In Stouffer, S.A. et. al. Measurement and prediction. Gloucester, Mass.

Haimes, Y.Y. and W. Ha.. 1974. Multiple objectives in water resources systems analysis. The surrogate: worth trade-off method. Water Resour. Res., 10(4): 615-624.

Hamblin, R. 1971. Ratio measurement for the social sciences. Social Focus. 50(2); 191-206.

Hamblin, R. 1974. Social attitudes: Magnitude measurement and theory. In Blalock, H.M. Jr. (3d.) Measurement in the social sciences. Aldine Publ. Co. Chicago, Illinois, pp. 61-120.

Hamill, L. 1975. Analysis of Leopold's quantitative comparisons of landscape aesthetics. J. Leisure Res. 7(1):16-18.

Jaakson, R. 1970. A method to analyze the effects of fluctuating reservoir water levels on shoreline recreational use, Water Resour. Res. 6(2).

Jackson, C.L. 1972. Scenic Resources: A study of scenic preferences. Dept. of Recreation Resour. Colorado State Univ. Fort Collins, Colorado.

Lazarsfeld, P.F. 1948. Chapters 10 and 11. In stouffer, S.A. et. al. Measurement and prediction. Gloucester, Mass.

Leopold, L.B. 1969a. Landscape esthtics: How to quantify the science of a river valley. Natural History pp. 37-44.

Leopold, L.B. 1969b. Method for measuring landscape appeal. Natural History pp. 36-45.

Lerner, L. 1962. Quantitative indices of recreational valves, water resources and economic development of the west. Rep. No. 11. Economics in outdoor recreation policy. Univ. of Nevada, Reno, Nevada.

Litton, R.B. 1968. Forest landscape description and inventories: A basis for planning and design. Res. Paper PSW-49, Pacific Forest and Range Exper. Station, USFS, Berkeley, California.

Litton, R.B. et. al. 1971 An aesthetic overview of the role of water in the landscape. Prepared for the National Water Comm., Dept. of Landscape Architecture, Univ. of California, Berkeley.

Litton, R.B. 1972. Aesthetic dimensions of the landscape. In Kuitilla, J.V. (ed.) Natural environments: Studies in theoretical and applied analysis. Resources for the Future, Inc. John Hopkins Univ. Press, Baltimore, Maryland.

Masteller, W.H. Andrews, L.C. Langord and G.E. Madsen, 1975. "Measurement of Stream Flow Aesthetic Values," Chapter 7 in Methodologies for the determination of stream resource flow requirements: An assessment, C.B. Stalnaker and J.L. Arnette (eds.) U.S. Fish and Wildlife Service, Meredith, D.B., and B.B. Ewing. 1969. Systems approach to the evaluation of benefits from improved Great Lakes water quality. In Conf. Proc. of the Internat. Assoc. of Great Lakes Resour. Manag. pp. 843-870.

Metfessel, M. 1947. A proposal for quantifying reporting of comparative judgments. J. of Psychology. 24: 229-235.

Michaelson, E. 1974. Aesthetics of wild and scenic rivers: A methodological approach. Water Resour. Inst., Univ. of Idaho, Moscow, Idaho.

Miller D.C. 1970. Handbook of research design and social measurement. 2nd ed. McKay and Co., New York.

Morris, J. 1974. Report on the need for an expanded program of data collection and evaluation of in stream-flows for recreation and aesthetics. For submission to the ad-hoc In-Stream Flow Study Evaluation Committee, Pacific N.W. River Basin Comm., N.W. REgion Bureau of Outdoor Recreation.

Mueller, G.H., R. McLachlan, and D.A. Morrison 1974. Visual perception in outdoor environments. Northeast Exper. Station, USFS, Upper Derby, Pa.

Northeast Region, Bureau of Outdoor Recreation. 1970. Draft report of the Kanawha River basin comprehensive study. Bur. Outdoor Recreation, Unpub. MS, 87 p.

Northwest Region Bureau of Outdoor Recreation. 1974 Recreation- Chap. 12, In Bayha K. (ed.). Anatomy of a river. Report of the Hells Canyon Task Force. Pacific N.W. River Basins Comm. pp. 123-147.

Oppenheim, A.N. 1964. Questionnaire design and attitude measurement. Basic Books, New York, N.Y.

Osgood, C.E., G.J. Suci and P.H. Tannenbaum. 1957. The measurement of meaning Univ. of Illinois press, Urbana, Illinois.

Peterson, G.S. and E.S. Newman. 1969. Modeling and predicting human response to the visual recreation environment. J. Leisure Res. 1(3): 237-239.

Redding M.J. 1973. Aesthetics in environmental planning. Office of Res. and Develop., EPA, Washington, D.C.

Stalnaker C.B., and J.L. Arnette (eds.) Methodologies for the determination of stream resource flow requirements: An assessment. 1976. Prepared for U.S. Fish and Wildlife Services Office of Biolog. Serv. West Water Allocation by Utah State Univ. Logan, Utah. Chapters 6 and 7.

Shafer, E.L., JR., and J. Mietz. 1970. It seems possible to quantify scenic beauty in photographs. Res. Paper N.E.-162. Northeast Forest Exper. Station, USFS, Upper Derby, Pa.

Shafer, E.L., JR., and T.C. Richards. 1974. A comparison of various reactions to outdoor scenes and photographs of these scenes. Northeast Forest Exper. Station, USFS, Upper Derby, Pa.

Stevens, S.S. 1960. The psychophysics of sensory function. Amer, Scientist. 48(2):226-253.

Stevens, S.S. 1962. The simplicity of sensory metrics. Americ. Psychology. 17:29-39.

Stevens, S.S. 1966. A metric for social consensus. Science. 15:530-541

Stouffer, S.A. et. al. 1973. Measurement and prediction. Gloucester, Mass. Peter Smith (Reprint of 1948 edition of Princeton University Press.)

Swets, J.A. W.P. Tanner, JR. and T.G. Birdsall. 1961 Decision processes in perception. Psychological Review. 68(5): 301-340

Taylor, J.B. and H.G. Parker. 1964. Graphic ratings and attitude measurement: A comparison of research factors. J. of Applied Psychology. 48(1) 37-42.

Techcom 1974. Technical Committee of the Water Resources Research Centers of the Thirteen Western States. Water resources planning, social goals and indicators: Methodological development and empirical test. PRWG 131-1 Utah Water Res. Lab., Utah State Univ. Logan, Utah.

Thompson, J., and R. Fletcher. 1972 A model and computer program for appraising recreational water bodies. Project C-3379 - OWRT-USD3 PWRG-112-3, 48p.

Urban, J.T. 1965. A white water handbook for canoe and kayak. Appalachian Mountain Club, Boston, Mass.

U.S. Forest Service, 1973. National Forest landscape management. Vol. 1, Agriculture Handbook. No. 434, USDA, Washington D.C.

Welsh, T.L., and D. Crouch. 1974. White water boating -- Chapt. 13. In Bayha, K. (ed.). Anatomy of a river. Report of the Hells Canyon Task Force. Pacific N.W. River Basins Comm. pp. 149-154.

Zube, H. 1974. Cross disciplining and intermode agreement on the evaluation of landscape resources. Environment and Man 6(1):69-89.

A NEW INTERAGENCY APPROACH TO DEVELOPING IMPROVED INSTREAM FLOW METHODOLOGIES

Robert P. Hayden
Office of Biological Services
U.S. Fish and Wildlife Service
Washington, D.C. 20240

ABSTRACT

A study and associated workshop sponsored by the U.S. Fish and Wildlife Service concluded that a number of locally applied instream flow methodologies are ready for further refinement and testing in preparation for more widespread application. To accomplish these tasks a Cooperative Instream Flow Service Group is currently being established as a satellite to the Service's Western Energy and Land Use Team in Fort Collins, Colorado.

The Cooperative Service Group will provide a focus for the multitude divergent activities underway in instream flow methodology development, and insure interagency and interdisciplinary input by its staffing pattern and program of multi-agency involvement. In addition to direct services which can be provided to a variety of Federal and state agencies, applied research will be conducted, computer routines developed, authoritative information supplied to field practitioners, and handbooks published and distributed. This approach is expected to accelerate methodology development by improving the development process itself.

INTRODUCTION

It has become widely recognized in recent years that effective water resource planning requires improved methodologies for determining the flow of water necessary to support instream uses. Since many state and Federal agencies either share responsibility for determining instream flows or are affected by instream flow requirements, a wide variety of methodologies have been developed and currently applied to meet the diverse needs of these agencies.

Fish and Wildlife Service field offices are deeply involved in instream flow determinations. As a first step of an augmented effort to increase the effectiveness of these field offices, the Service contracted with Utah State University to conduct a state-of-the-art study which pulled together into one report the current status of the efforts of the many individuals, groups, and agencies involved in instream flow methodology development. The final report, entitled "Methodologies for the Determination of Stream Resource Flow Requirements: An Assessment", evaluates the adequacy of existing methodologies for determining the necessary stream flows for fish, wildlife, water quality, recreation, aesthetics and other instream uses; and recommends needed research and development in each area.

The results of this study and the problems encountered in developing methodologies for each major instream use area have been discussed by others in this session. An additional aspect of the study not previously presented is the insight we received into how instream flow methodologies have been and are being developed. The purpose of my remarks is to present some of these general insights, and to outline our concept of an organizational approach which we believe will accelerate development of improved methodologies by compensating for shortcomings in the current methodology development process itself.

GENERAL CONCLUSIONS REGARDING THE STATE-OF-THE-ART

The final report from Utah State University contains a significant quantity of new information. The magnitude of this previously unpublished material is an indication of the current activity in the field and points up the need for a focus of information gathering and dissemination in this area. Other factors of the instream flow methodology development process brought to our attention by the study include:

1. Most methodology development takes place on an ad hoc basis in geographic and/or disciplinary isolation.
2. Methodologies are commonly developed for local or regional application to a particular problem by individuals who return to other duties once the task is completed. The result has been a lack of continuity in methodology development and refinement.
3. There has been little or no comparative testing of different methodologies on the same stream.
4. Existing methodologies generally have not been tested in or applied to regions other than the region of origin.

Based on these factors, the discussions at the instream flow workshop in Logan, Utah, last fall, and the evaluation of the state-of-the-art study, we have reached the following overall conclusions:

1. A number of methodologies are ready for refinement and testing in preparation for widespread application.

2. A concerted, focused effort is needed.
3. A mechanism to share information and findings among practitioners is essential.

Since the problems associated with instream flow determinations are both interagency and interdisciplinary, we should expect that the solution to the problem of developing adequate methodologies will most likely be found in the intersections between overlapping disciplinary and agency concerns.

A COOPERATIVE INSTREAM FLOW SERVICE GROUP

As the next step toward developing improved methodologies and creating a national program of sufficient scope and adequate funding to address the issue of instream flow needs in a comprehensive manner that is also a well coordinated state and Federal joint venture, the Fish and Wildlife Service is currently staffing a Cooperative Instream Flow Service Group as a satellite of our Western Energy and Land Use Team in Fort Collins, Colorado.

The Cooperative Instream Flow Service Group will be composed of persons with a variety of organizational and disciplinary backgrounds and will address two particular areas of instream flow needs: the biological component, and the decisionmaking component. The inclusion of both components in close coordination is essential. The biological component is essential for the development of adequate methodologies to determine actual requirements of fish and wildlife and other uses for instream flows. Application of proven methodologies may be negligible, however, unless adequate attention is paid to the means of maximizing implementation in the decision arena. Constant feedback between the two components is needed to keep biological investigations focused on relevent recommendations, and the assessment of legal implementation strategies focused on ecologically sound principles.

Location of the Service Group at Fort Collins will provide access to locally available computer facilities, commercial transportation connections; and maximum interaction with members of the Service's Western Energy and Land Use Team and personnel of other agencies and institutions actively involved in methodology development.

Relationship of the Service Group to State and Federal Programs

Although the Service Group will be administered and initially funded by the Fish and Wildlife Service, it will have a multi-agency character reflecting the responsibilities and interests of many agencies in instream flow studies.

The multi-agency character of the Group will be reflected in several ways:

1. Staffing for the basic operating level will be provided by the Fish and Wildlife Service through direct funding. State personnel may participate through provisions of the Intergovernmental Personnel Act with Fish and Wildlife Service funding. Staffing can also be supplemented by other Federal agencies through special assignment.
2. Direct services can be provided to a variety of Federal and state agencies.
3. Funding, in addition to the basic operating level provided by the Fish and Wildlife Service, will be sought from other Federal agencies to broaden the Group's service capability and to enable it to perform contract research.

The initial amount of funding is sufficient to support limited participation by the Fish and Wildlife Service and state fish and game agencies in water resource planning. The initial funding will also support dissemination of a moderate amount of information to interested agencies. Financial involvement of other agencies will be required, however, to broaden the Group's service capability beyond this basic operating level to meet individual agency requirements.

Service Group Functions

The Service Group will provide the following direct services to Fish and Wildlife Service and state fish and game field units, and if requested to other Federal and state agencies:

1. Training field personnel in the application of instream flow methodologies.
2. Generating specific instream flow recommendations through application of stream flow methodologies on a computer-based system.

3. Informing practitioners of current activities, new methodologies and new research results.
4. Developing, maintaining, and circulating a directory of active workers in instream flow methodologies.
5. Recommending appropriate methodologies for particular circumstances and implementation strategies which are found to be particularly effective.

In addition to the direct services to be provided, the following specific tasks will be undertaken by the Service Group:

1. Refining and testing existing methodologies for widespread application. Evaluation will include comparisons of water flow recommendations, cost of implementation, and data requirements.
2. Publishing, distributing, and updating handbooks on instream flow methodologies for field biologists, water planners, and decisionmakers.
3. Developing an automated information storage and retrieval system which includes data, flow recommendations, the methodologies applied, and references to original documents.
4. Keeping current on the state-of-the-art of instream flow methodologies for fish, wildlife, aquatic organisms, water quality, recreation, aesthetics, and ecosystem management; and informing practitioners of new developments.
5. Keeping abreast of legal developments and decisionmaking processes in instream flow requirements.
6. Developing improved methodologies for determining instream flow requirements.

Personnel and Staffing Patterns

Staffing at the basic operating level will consist of a Coordinator with a broad range of experience in the biological and institutional aspects of instream flow needs, supported by four other professionals. To insure a balanced interdisciplinary team, expertise in at least the following fields will be included among the staff members: fisheries biology, electronic data processing, water law and decisionmaking, and hydrology. Three regular positions and three intergovernmental transfers or assignments will be required for the basic operating level as follows:

Group Coordinator Aquatic Ecologist Secretary	Permanent Fish and Wildlife Service staff
Staff Specialist Staff Specialist Staff Specialist	Intergovernmental transfers or special assignments in appropriate combination to represent adequately the disciplines listed above.

While the initial support for this Group will come from the Fish and Wildlife Service, the results will benefit a variety of other resource agencies. It is expected, therefore, that cooperation from agencies such as the Forest Service, the Water Resources Council, and the Environmental Protection Agency will enhance the program's capabilities through increased technical support staff, financial aid, and other forms of input.

Funding Requirements

The Cooperative Instream Flow Service Group is being chartered for a period of three years. The annual budget for the basic operating level is as follows:

Five (5) Professionals and one (1) Secretary	$190,000
Travel	35,000
Computer Time	25,000
	$250,000

The proposed users at the basic operating level supported by the Fish and Wildlife Service include:

Fish and Wildlife Service - Area Offices (Ecological Services)

Fish and Wildlife Service - other field units

State Fish and Game Agencies

Special Interior Department Planning Efforts

Additional support is being solicited from other agencies in the form of matching funds for studies and personnel at the appropriate level to broaden the service capability of the Group to serve the needs of each agency. Potential users, with interagency support, include:

Corps of Engineers

Forest Service

Bureau of Outdoor Recreation

Water Resources Council

River Basin Commissions

State Water Resources Agencies

National Marine Fisheries Service

Bureau of Reclamation

Bureau of Land Management

National Park Service

Environmental Protection Agency

Energy Research and Development Administration

Soil Conservation Service

Bureau of Indian Affairs

The Cooperative Instream Flow Service Group is an exciting concept. With this interagency approach, rapid progress in methodology refinement and testing is expected. Your comments and suggestions will be most helpful in shaping the Service Group's program.

TOPIC II-B.

METHODOLOGIES--A STATE-OF-THE-ART REPORT

Summary Discussion

The papers in this section (II-B) present in summary form the results of an in-depth study of all aspects of instream flow methodologies which was conducted at Utah State University under contract with U.S. Fish and Wildlife Service. Following the preparation of an initial draft of this state-of-the-art report, the U.S. Fish and Wildlife Service sponsored an Instream Flow Workshop held at Utah State University in Logan on September 17-19, 1975. The workshop was conducted to evaluate the quality, accuracy, and level of comprehensiveness of the draft document. To accomplish this objective, the workshop participants (acknowledged practitioners of various fields of stream flow assessment) gathered in work groups for evaluations within their specialty. To further the evaluation, various speciality work groups met and discussed interdisciplinary consideration.

The report "Methodologies for the Determination of Stream Resource Flow Requirements--An Assessment" (Stalnaker and Arnette, 1976) presents the results of the study and workshop conducted at Utah State University. This document represents an initial effort by the Western Water Allocation Project of the Fish and Wildlife Service to determine the state-of-the-art of instream flow methodologies. As the report indicates, the adequacy of the methodologies available for determining instream flow requirements varies considerably among uses. Although additional investigation seems to be called for in several areas, this report represents the most comprehensive compilation of methodologies available to date. It is made available in its present form to provide field workers and planners with an immediate interdisciplinary reference source and to stimulate a continuing flow of ideas and dialogue. This report examines existing techniques and methodologies and discusses each relative to their applicability to: 1) reconnaissance studies; 2) on-site studies requiring limited field measurements; and/or 3) intensive on-site studies requiring substantial and sophisticated field measurements.

The objective of the report is to document (reference) current methodologies and critique them with emphasis upon identifying constraints. This document is not meant to be a manual of methods and procedures, but rather a state-of-the-art summarization to provide: 1) the basis for further work toward the development of a manual of instream flow methodologies for use by management personnel;

2) designation of criteria for development of a comprehensive set of methodologies for determination of flow requirements for aquatic life, fisheries and wildlife, water quality, estuarine inflow, recreation, and aesthetics; and 3) to define areas of research needs.

This report was not intended to include all materials that might have been written on the various uses, but has certain limitations. First, highest priority in the search was given to materials most directly related to effects of stream flow variation. Second, materials were included that could be adapted to the methodological needs of flow assessment. This basic approach was constrained by the fact that in some areas no methodological materials were found that had been specifically developed for the purpose of evaluating the effects of differential stream flows. Third, the scope of the work (relative to fish and wildlife uses) was extended to determine how individuals in agencies are making current decisions and recommendations without specific standardized principles to follow.

Section 1 attempts to identify the terminology in general usage among various agencies, disciplines and personnel when discussing the problems of stream flow and instream requirements. It suggests a standard set of appropriate terms and definitions for use in further discussions of instream flow problems as well as in the test.

Section 2 discusses stream flow measurement in the context of establishing standard techniques of measuring stream discharge under different physical and time constraints. This section is included to contrast measurement techniques and methodologies (including analysis and interpretation). It should be considered a common point of reference from which the remaining sections discuss need assessment and methodology development and utilization.

Section 3 discusses modeling techniques and summarizes applications to hydrodynamics and water quality dynamics in rivers and estuaries. Models of flow, dissolved oxygen, temperature, total dissolved solids, sediment transport, nutrient budgets, and microbial ecology are included. Most of the comprehensive models discussed were originally constructed to examine the dilution needs for dissolved oxygen maintenance by expanding and modifying the classic Streeter-Phelps equation to fit variable biochemical oxygen demand discharge circumstances.

Section 4 summarizes the methods and approaches as they have developed and are being utilized for assessment of the aquatic habitat. This section emphasizes the fauna and more specifically the fishes. Most of the methodology development to the time of this writing had concentrated upon particular life stages of the salmonids. Consequently the organization of this section has been related to the reproductive (spawning), migratory (passage), food (benthic insect-riffle production), and shelter (instream, micro-habitat, cover) needs of fishes.

Section 5 presents a discussion of methods that have been used to evaluate the effects of water resource and other developments upon wildlife populations. Emphasis is placed upon needed methodologies and research applicable to the problem of stream flow alterations.

Section 6 is directed toward the measurement of recreational behavior and the assessment of social attitudes which affect demand for stream-associated recreation resources. Other approaches are presented which attempt to determine the recreational opportunities that may be available.

Section 7 focuses upon aesthetic considerations of flowing streams (fluctuations in the waterscape) and the associated landscape. Aesthetics, not necessarily involving activity, but rather sensitivity or emotional evaluations has been investigated more by psychological methods. Measurement of aesthetics is discussed with emphasis upon viewer evaluation (psychological scaling) and environmental qualities (classification). As is pointed out, methodologies for assessing stream aesthetics need to incorporate both techniques (methods).

To reiterate, this report does not specifically address the decision making process and the total planning concept, but is restricted to a discussion of those techniques and methods used for assessing the effects of changing stream flows.

Notes by panel moderator: Clair B. Stalnaker
Steering Committee Member

DATA NEEDS FROM BIOLOGISTS FOR PROTECTING INSTREAM FLOW

Walter T. Burkhard
Colorado Division of Wildlife
Grand Junction, CO 81501

ABSTRACT

In order for the biologist to be successful in his request for instream flows, he has to develop credibility in techniques and his standing among his peers. The first step in developing this credibility is through the use of uniform and accepted methodology. This must include specific biological and hydrological parameters. He must also be able to clearly demonstrate the need for instream flows and show the alternatives if such flows are not granted.

Colorado is charged by law in filing on minimum stream flows in order to protect the natural environment. We are currently using the U.S. Forest Service R2 Cross program for obtaining stream profiles and computer modeling for synthetic flow parameters. Weaknesses in the techniques are being evaluated and possible remedies are being studied. Biological data needs is briefly discussed. Once the field data is collected, the biologist must become familiar with past hydrology and complete legal descriptions of the areas involved. He must make his request for instream flows reasonable and he must develop a defense to use in court. He must be able to relate fish habitat and biomass with water volume. His presentation must be simple enough for lay people to understand and the use of visual aids is recommended.

INTRODUCTION

Due to the ever-increasing demand on our water resources, we have reached a point in time where we are forced to compete for water to protect our recreational resources which include fish and wildlife and just plain esthetics. In order to be successful in this competition, we must be able to substantiate our needs and have them accepted by the general public. To the biologist this means he must supply data of a type that is acceptable to his colleagues and to our courts. He must also prove the need for the request and clearly show the alternatives if the requests are not granted. This type of data is not easily obtainable. I will show some of the problems Colorado is having and methods used to establish our credibility and in preserving instream flows for recreation.

Colorado Stream Preservation Law

Although it may be repetitious to this group, a brief description of Colorado's Stream Preservation Law is necessary. In 1973 the State

Legislature passed an act charging the Department of Natural Resources, through the Water Conservation Board and the Division of Wildlife, to make water filings on all the streams, rivers and lakes in the state. The filings are to be made on minimum stream flows that "will protect the natural environment to a reasonable degree." If the filing is adjudicated by the water courts, Colorado is given a water right that is dated at the time of approval. Because of Colorado's Prior Appropriation Law our water rights will be so junior that in a great many cases our chances of getting water are slim. However, it does give us some say when it comes to changing points of diversion and we do have the opportunity to purchase water.

Field Data Methodology

The first and possibly the most important step in obtaining field data for instream flow requests is the development of uniform and acceptable methodology. This methodology, which includes well-defined biological and hydrological parameters, must be above criticism from any agency or group involved in water use. Once this methodology is developed, tested, and accepted, credibility is established and the data and instream flow requests can be reviewed on their own merits.

Due to the number of streams involved and a lack of manpower, Colorado is forced, in most cases, to use a one-shot field investigation for each stream. All other data must be obtained from past records. Data collected in the field includes the hydrological characteristics of the stream and as much biological data as possible. Since we have several crews in the field, the importance of uniformity is again stressed. We are currently using the R2 Cross method of stream profile as developed by the U.S. Forest Service. While this method has some limitations, it is easily duplicated and does permit computer modeling of synthetic stream flows. This ability to generate stream characteristics of a multitude of flows from one set of field measurements is invaluable. Two weaknesses in this method which we are currently trying to improve upon are: the accuracy of the physical parameters of the synthetic flows mainly because of the values used for Manning's N or roughness coefficient in the equation and secondly, the accuracy of the equipment used to measure slope or gradient of the stream. We are also investigating ways to resolve the problem of the roughness coefficient. We are open to any new or better method should it come along. We are presently using hand levels for slope determination but are experimenting with Clinometers and possibly Alidades to increase this accuracy. If necessary, we may have to go to expensive surveying equipment and train our crews to use them.

One must also use care in making discharge measurements. Current meters should be periodically inspected and calibrated. Standard USGS Water Measurement Techniques should be strictly adhered to and records and notes kept in detail.

As far as the types and accuracy of the biological data goes, several things must be determined. I won't go into sampling techniques because they are so diversified according to the situation and most of them are acceptable to the profession. If the data is available elsewhere it need not be repeated in the field survey. The important things needed are: Fish species present, is the population natural and self-sustaining or must it be maintained by periodic stocking? Are there any rare or endangered species present? Is the population up to its maximum or could flow manipulation improve it? Does the fishery or the area have some special importance due to its uniqueness or because of its location? All of these and more will have a bearing on justifying instream flow requests.

Development of Recommendations

With this field data in hand the biologist can now retire to the office, gather about him all the past hydrological records, maps, legal descriptions of the areas, and any other information available to him and begin to work up his recommendations. As he begins work on this, he must resolve in his own mind, the difference between an optimum flow, one which will provide an acceptable and sustaining fishery, and a minimum or survival flow, which is one that fish can survive in but will not support a fishery. He must become completely sure of the runoff patterns of the stream, not only in volume but in daily and monthly patterns. If he is lucky he will have USGS records to use because he needs to know historic maximums, minimums, and means. A flow hydrograph covering at least 10 years can be invaluable. He must be sure of the legal description of the area he is involved in. Colorado has some areas that have not been surveyed into sections and townships and one has to revert to latitude and longitude to describe the area. He must decide if a one-shot yearly flow is sufficient or is there a reason to recommend flows on a monthly basis. In Colorado either is acceptable but must be qualified to include "or the natural flow if less."

Now let us assume that the biologist has all the data necessary, he is sure of its accuracy, and through an orderly process, has arrived at a recommendation. He is going to recommend a flow of 30 cfs or the natural flow if less for Beaver Creek from its confluence with Sargent Creek upstream to the Highhat Diversion Canal.

Defense of Recommendation

He must now prepare a defense for his recommendation. His presentation must be accurate and contain sufficient data but it also must be simple enough for lay people to understand. A series of slides that depict flow extremes can be helpful. A slide can show the difference between good fish habitat and poor habitat yet they are difficult to explain verbally. Although it is difficult one should be prepared to show with figures what will happen to the habitat if your recommended flow is reduced 5 cfs or 10 cfs. One question we always seem to get is how many fish will you lose if we reduced your flow to 25 cfs? This is a hard question to answer but if you can get them to understand that it is a loss in habitat and carrying capacity your job will be easier.

Submission of Recommendation

It is at this stage that the recommendation is submitted. In Colorado the process is as follows. The Instream Flow Request is submitted to the Water Conservation Board which is composed of nine members appointed by the Governor and four members from state departments. They review the request and if approved, it goes to the Attorney General's Office and a formal application is written. This goes to the Water Court where it is subject to public review and comment for 60 days. If no objections are raised, the Water Referee reviews the request and the decree is issued. If a protest is raised, it goes before the Water Judge and the biologist ends up in court defending his request.

SUMMARY

To recap on the data needs from the biologist, the following cannot be stressed enough:

- The methodology must be uniform and accepted by all agencies involved.
- Accuracy and strict adherence to procedures is a "must."
- Be sure your data is complete and your request is reasonable.
- Be ready to defind your request in court.
- Keep your defense simple but clearly relate it to the biology.

THE LEGAL PROCESS--WHAT IS NEEDED IN COURT

By Jack G. Collins*
First Assistant United States Attorney
United States Attorney's Office
for the District of Oregon
Portland, Oregon 97207

ABSTRACT

In court we rely upon an adversary process in seeking truth. Most courtroom processes are organized in four parts, legal framework, evidence to support this framework, a manner of presenting this evidence and methods of overcoming similar efforts by an adversary. This adversary process uses rules of evidence which rely heavily upon those who perceive events through their five senses. Scientific evidence of the nature, source and amount of stream inputs and withdrawals remain essential for streamflow litigation. Procedures for obtaining such evidence are suggested, e.g., chain of custody procedures, data and testing procedures review with lawyers and photographs. Quantification of injury and damages has not been adequate.

Somewhere beyond our administrative, scientific and scholastic horizons lies another country--the courtroom. Most of us would prefer not to go there. If we do, we shall find its members using an adversary process in seeking truth and resolving disputes. We shall also find this adversary process severely stressed by an increasing volume of litigation and modified toward an investigative model.

The courtroom adversary process which we have developed in this country is carried on within an elaborate framework of statutes, rules and custom. Paramount among these are what we refer to as the "Rules of Evidence." These Rules of Evidence present an opportunity for testing the quality of evidence that will be considered by the trier of fact, either a judge or jury. Many of my scientific friends are often amazed to learn that

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* Member, Oregon State Bar. A.B. Princeton University 1952; L.L.B. Harvard University 1958. First Assistant United States Attorney for the District of Oregon, Portland, Oregon.

The views expressed in this article are those of the author and do not necessarily reflect the views of the United States Department of Justice.

their hypotheses, which they use everyday, are often not able to withstand a lawyer's objection of "hearsay"--an out of court statement offered in evidence for its truth by someone other than the person who made it.

Lawyers who work in courtrooms have a great preference for evidence reported to the court by a witness who perceived it with one or more of his five senses. Most courtroom lawyers would rather suffer the shortcomings of a witness' perception (and they are many) than speculate on the shortcomings of someone's perception who is not present. Most of us who work in courtrooms also believe that an oral-visual presentation conveys much more information more quickly to a trier of fact than a written presentation. These are two reasons why many of us are not pleased with the present trend in many of our courts to set down large amounts of oral-visual testimony, of both expert and lay witnesses, in writing to be read at a later time. It has become a fact of modern courtroom life, however, that a conclusion should be stated at the outset of a presentation and its supporting evidence summarized afterwards. The play's climax should come in the first act, because the second and third acts may be reduced to writing and read another day. Our presentations have become a race of disclosure.

A trial lawyer's job remains, however, to organize and present his client's claims in their most persuasive form within this adversary process. Most trial lawyers tend to organize their courtroom presentations into four parts: A legal framework, evidence to support this theoretical framework, a manner of presenting this evidence and methods of overcoming similar efforts by their adversary.

This conference has been concerned with Instream Flow needs. Courtroom lawyers have not given much attention to this subject in the past. Most of you will have difficulty recalling a case in which a judge or jury rendered a verdict in favor of a private party for money damages relating in any way to an Instream Flow. Many of you may have equal difficulty remembering an actual trial of a claim by some unit of government against a private party relating to streamflow at all. This situation will change in the next decade.

There are several reasons why litigation involving natural resources, including streamflows, will increase in the coming decade. These reasons also influence what is needed in court. A few of them are as follows. First, our views are changing about what we previously regarded as "free" goods--resources held in common, such as water and air. These resources are not only acquiring monetary value, but also are recognized as having certain ecological and esthetic values. A legacy of our space photography of planet earth is a recognition that our world is finite, that we really do live in a world of scarcity. Disputes involving the quality and allocation of these formerly "free" goods may be expected to increase our courtroom work.

Second, our views of property are changing. Many of us no longer view ownership of land as giving as complete a degree of dominion as in prior years. The tendency is to consider property as the extent of our rights to use particular resources for a limited time and in a limited fashion. Such a conditional view of ownership will generate litigation among those who believe these conditional limits have been exceeded or require clarification.

Third, new management systems are being created to administer our attempts to manage the quality of our environment. The regulations of these new federal, state and local managers are building a new body of regulatory law whose development and enforcement will provide more work for courtroom lawyers.

Fourth, our legal theories are catching up with these changes. We no longer rely so heavily upon theories of recovery for injury to possessory interests in private property, such as trespass, negligence and nuisance. Statutes now provide government and private parties with means of determining and enforcing their limited rights to use and maintain the quality of our common property. Government can expect to find itself more frequently between competing views of resource management. As a result, our courts will be called upon to act as arbiters in such cases.

The varying types of regulatory patterns which are emerging and which relate to Instream Flows create other problems for a trial lawyer. He must decide to what extent his client's best interests call for reliance upon an existing administrative record. If such a record is favorable, he will probably wish to limit the scope of a trial court's consideration to that record. If that record is not favorable, he may wish to expand it and perhaps go so far as to obtain a trial de novo--a trial of the matter anew or from the beginning again. Courts are more inclined to limit their review to an administrative record where that record has been produced in an adjudicatory process before an administrative law judge with a transcript of the proceedings and with evidence presented in an adversary framework. Courts are more inclined to open up a record and permit additional evidence or a trial de novo where the administrative record is limited to internal agency files and does not contain outside or independent review and comment. In their infancy regulatory programs have often tended to generate records of this non-adjudicatory type. Stream flow regulation tends to follow this pattern also.

Attempts to open up such an informal record will generally begin with a series of procedural challenges and questions, such as: Is a permit in fact required for a particular use or discharge? From whom? Was it timely applied for? Is a hearing upon such a permit application discretionary or required? Is such a hearing of a legislative or adjudicatory nature? Is there an appeal or review provided for the denial or issuance of such a permit? What is the standard of any such appellate review of the denial or issuance of such a permit? Must a person exhaust this administrative review before commencing an action in court? Who, if anyone, has suffered an injury in fact? And finally, can you recover attorney's fees? At this point some of you may ask, "Is anybody really interested in what's happening in the stream or water body?"

The answer is that a great many people are interested and have evidence to give. The job of the trial lawyer is to quickly marshal these facts and present them in their most persuasive form. At the outset there should be a survey of the basic relevant factual material easily assimilated by lay persons and visually displayed to the Court and jury, if possible. Photographs are almost a necessity. A picture is still worth a thousand words. For example, a photograph will not only show the breadth and color of an oil spill, but also may show the size and navigable character of the water body being polluted.

There must be identification of any particular stream input or withdrawal, its nature, source and amount. Lay witnesses may be sufficient to establish these facts, but most trial lawyers insist upon a qualified person with appropriate scientific training who tested and identified or otherwise measured the amount of any particular matter, including water, entering a stream or being withdrawn from it.

One of the most useful things you can do in this regard is to establish a procedure for a chain of custody within your agency. It will often be necessary to prove that, not only is the sample your expert tested the one that came from a particular stream, but also that it is the one which has been produced in court and about which the expert is testifying. Under many circumstances you may have to produce every person who handled that sample from the day it came from the stream until it appeared in court. As you can see, chains of custody should be short, well established and samples retained. Cross-examiners delight in breaking down a chain of custody, thereby impairing the integrity of the sample and the testimony of the expert about it.

Please give some thought to reviewing with your lawyers the testing and measuring procedures and the data upon which your experts rely. If possible, walk your lawyers through your laboratories. Let them watch some similar testing being performed. Let them ask lots of "dumb" questions. Point out to them the shortcomings of your work as well as its strengths. This will not only help prepare them for examination of your experts, but also will anticipate cross-examination. If you have employed mathematical or computer or physical stream similation models, you should walk your lawyers through them from beginning to end. Most lawyers cannot handle at the outset the distinctions in these techniques.

You may wish to consider having certain members of your organizations answer the increasingly frequent calls for expert testimony. Such a procedure may not only be more economical, it may also take advantage of particular talents and experience which exist in most large organizations. It also has the advantage that personnel will become acquainted with lawyers who frequently deal with them. In the course of such acquaintances enormous amounts of information are passed informally back and forth. All of this makes for better courtroom presentations.

My preference is to also have several witnesses who can present the kind of evidence that appeals to "every man"--the color, touch and smell of bunker C crude oil as it covers a particular shoreline. Although this conference is concerned with some very sophisticated concepts of streamflows, there are still advantages to having "the old timer" who can give historical background of a locality and remembers how this particular stream appeared before the advent of a particular project which has been the subject of litigation.

After all this, some of you may say, "Thank you very much for identifying and measuring whatever it is that is going into this stream, but how much does it hurt?" The subject of damages is worth special mention. To the private practitioner it is often the source of his fee. To the plaintiff seeking an injunction it is the irreparable injury that money cannot measure or compensate. In the federal courts some of us detect a trend toward requiring a plaintiff to actually prove an "injury in fact" as a condition to even opening the federal courthouse door.

Ecologists have not been particularly helpful to trial lawyers in measuring damages. Among their problems appears to be the newness and complexity of their science and their inability, as yet, to quantify the effects of a particular environmental change without enormously time consuming and expensive studies that are not as a practical matter available. There may even be theoretical limits upon such measurement by virtue of a change in the environment caused by the insertion of the observer conducting the measurement. Lawyers have had much more success collecting damages for the blackening of the white painted sides of a yacht by oil then for the same oil killing even one salmon or water bird. Governments can impose penalties for such discharge of pollutants, but most of us would like to be more precise because some of us believe the actual monetary damages are much greater. Some of us would like to quantify in monetary terms the full environmental costs of changes in streamflows. Some of us are looking for ways of measuring with some precision the full environmental impacts of the kinds of changes in common property we are dealing with at this conference. We would like to cost out these changes and send either someone or all of us the bill. Perhaps you, as well as the economists, can help us.

Occasionally you will find a lawyer who would like to "look at the ground." Take him there. Take a day or two if need be. Have your field people and experts along if possible. Take lots of pictures. It is often on such trips while talking around some dry hole that the shortcomings of your data, and that of your adversary, come to light. These trips provide a lawyer with the details of local history and geography that enable him to later sound in court like he may know what he's talking about. Besides, lawyers like to get out of their office on a nice day like anyone else.

There is something more important trial lawyers can do for you. They can help present your best judgments as professional resource managers--quietly, effectively and free of political slogans and overblown cliches. This will become more important to you personally and your agents generally as our society asks for action from our resource managers, which requires a higher order of planning and projection than we know. Perhaps it is true that to retain our hopes, while recognizing our limits, requires a touch of greatness. The views, the judgments that you hold were not quite your father's nor will they be your children's. They may indeed turn wrong, but if today they are the very best among our work and hopes, then it is my privilege to help you say them, and say them well.

DATA NEEDS FOR DECISION-MAKING

C. Stephen Allred
Department of Water Resources
State of Idaho
Boise, Idaho

ABSTRACT

Instream flows for fish and wildlife needs may be critically affected in the western states in the next few years. Pressures are building to use water for diversionary uses. The success that instream flow interests have in obtaining allocations for instream purposes will depend upon how well they can relate the need and justification for such flows to the decision-maker. The type of analysis and method of presentation must relate to and enable the decision-maker to evaluate the proposal within his frame of reference. Types of analysis should relate flows amounts requested to the level of resource that the flow will sustain. Alternative flow levels and resource levels should be described. The affect and length of low flow durations should be described, and the purpose of the request should be fully defined with regard to the objective of the flow request. The request for instream flow must maintain credibility, particularly by analyzing and considering water availability and hydraulic analysis as well as biological analysis.

INTRODUCTION

Why are we collecting data on instream flow needs? I sometimes think that it is to grace the shelves of someone's bookcase. As I work with instream flow data of the type usually available, I become increasingly concerned that instead of developing data that the biologist believes is necessary, data must be developed that will influence those who must make the decisions to allocate water for instream flows purposes. Many times the method of presenting data to the biologist and the decision-maker are not the same. Whether we like it or not, our water allocation procedures, in addition to legal requirements, have been developed based upon the ability to evaluate trade-offs. Unless we recognize this difference in philosophy, we will not be successful in obtaining allocations that are necessary for fish and wildlife purposes.

The person responsible for making water allocations today is faced with decisions that involve complex legal and technical considerations. He cannot make decisions based upon single purposes without considering and comparing beneficial and adverse affects or laws and regulations that govern water uses. Decisions are increasingly being challenged in courts and decision-makers are becoming aware of the need to base their decisions upon sound information. In many cases, alternative decisions are mutually exclusive and the decision-maker must consider other opportunities foregone.

Decisions regarding instream flows usually involve the conflict between water for the stream and water for diversionary uses. Sophisticated methodology has been developed for evaluating tradeoffs between diversionary uses. Determinations can be made, within limits, how much revenue will be generated to the economy, how much the use will cost, how economic sectors will react, general social affects, and generally, the environmental impact that can be expected. However, with regard to instream flows for fish and wildlife, incremental affects to the resource from various flow levels are equally not available to those who have to make decisions. We do not say that if we have 75% of a flow identified as necessary to sustain a resource that we will maintain "x" percent of the identified resource. We have not as yet identified what happens to the resource during water shortages. When we discuss most diversionary uses, we plan to provide a certain percentage of normal requirements during the worst water condition. What percentage reduction can be applied to instream flows for short periods of time without seriously affecting the resource. Decision-makers, and the general public, are used to using these types of parameters when they consider water allocation decisions. The greatest number of such decisions in water allocation procedures will still relate to the diversionary uses. It is unrealistic to think that the current mechanisms will be changed drastically, when considering instream flows for fish and wildlife purposes. Therefore, if instream flow interests expect to compete with other uses for limited water supplies, they must be able to demonstrate with the same type of analysis and approach as other uses the need for instream flows and the affect of not obtaining those flows. I have witnessed too many situations where those seeking to justify a particular use have not been successful because they did not relate to the decision-makers perspective. The need for instream flow levels cannot be defended by contending that the failure to receive the desired flow will cause the resource to be lost. Very few decision-makers will believe that. They will accept, however, that if you reduce the flow "x" amount, you will get "y" amount reduction in that resource. Being able to present argument for instream flows with specific information on the consequences of not obtaining that flow will in the long run be more effective than depending upon emotional arguments.

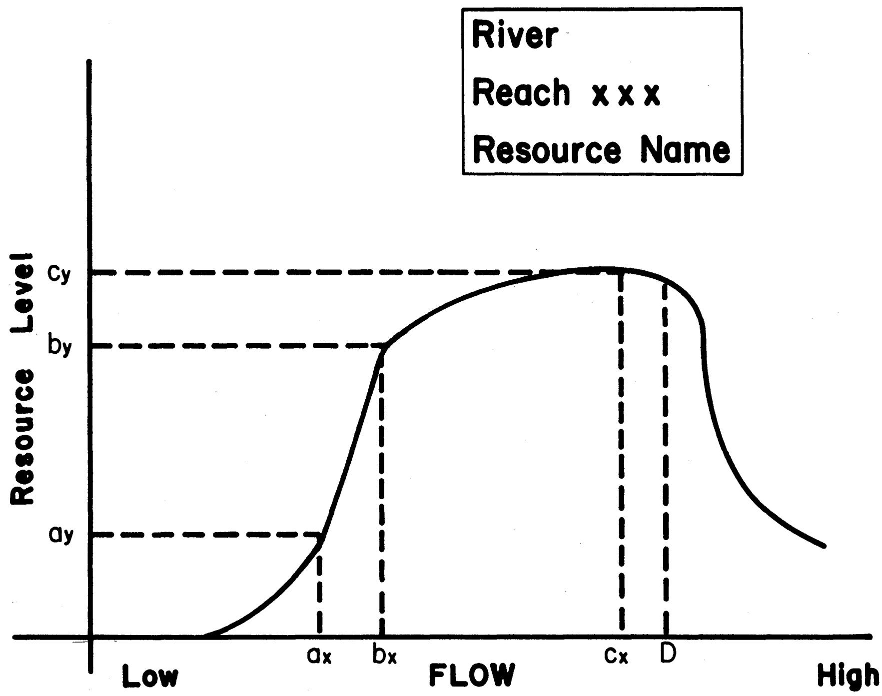
After deciding to compete in the same "ball game" as other water users, then the next decision is how best to present the case to obtain the goal. I don't think that I can over-emphasize "be realistic." The credibility of an applicant who requests an allocation from the water source that is physically impossible is severely damaged before they have an opportunity to present their case. Ecological determinations and hydrologic studies must go hand in hand. Those seeking instream flows must also realize that the water supply for which they are competing is usually very limited. Instream flow interests are not going to be successful in arguing for "extra" water to compensate for gross inaccuracies in determinations or methodologies. Other users are not successful in arguing for extra water for such contingencies and I can see no reason why instream flow interests would be.

Methodology and procedures to analyze the physical and biological data must be developed to enable predicting affects of differing flow levels on the resource. Some of the efforts presently underway may fill part of this need.

I would like to give you some of my thoughts as to the type of data presentation that should be made available to the decision-maker.

Flow Amounts vs. Benefits

In discussion with fishery interests, I have been concerned with their reluctance to identify the relative benefits versus alternative flow levels. I remember in one particular discussion, the response to my question of why such affects could not be identified was "if we identify that we can get along with less water, then that's what we will be given." The result of this approach is that the instream flow applicant ends up with no water or the allocation granted bears little resemblance to any biological or physical need. Requests for instream flows must be based upon the effect of not having the flow available instead of depending upon just emotional support to justify such flows. As water supplies become more scarce, the decision on allocation of the water that remains will be increasingly based upon analyses of tradeoffs. If instream flows are to compete for the water, then the analysis of affects of various flow levels must be made available in adequate detail to compete with similar types of information for other competing uses. It is too easy, when the affects of an alternative are not available and the requested amount cannot be supplied, to make decisions that bear little resemblance to actual needs of the resource. The same situation exists with regard to instream flows uses for aesthetics or recreation as well as fish and wildlife. Tradeoffs do not necessarily need to be described in monetary terms. They should be described by the paramater that best relates to the decision-maker. A general example of the type of presentation that may be meaningful to the decision-maker would be as follows.



Such an analysis would allow the applicant to demonstrate for the decision-maker the affect of not allocating water for instream flow purposes. Information presented in this manner would also allow the decision-maker, in those cases where he will not grant the requested amount, to allow a lesser amount that relates to an alternative resource level rather than outright denial of the request.

The same approach could be used to describe flows necessary for various resource uses.

Flow Duration

One of the parameters that the decision-maker must consider is the degree and length of time that a water shortage can be sustained without eliminating the benefit for which the flow is allocated. With diversionary uses, such as irrigation, planning is typically based upon supplying 50 percent of the annual requirement during the dryest year and no more than an accumulated shortage of 100 percent in any consecutive 10-year period. Similar criteria needs to be developed for instream flow uses. Idaho is utilizing in planning studies in the Snake River, a figure that represents the average monthly flow for the lowest 5 consecutive August flows to judge the affect of shortages upon instream flows. The reason to use such figures is to describe a time sequence that has some meaning to the use being considered. We have assumed that the same shortage criteria used for irrigation uses can be utilized. That criteria may bear little resemblance to environmental reality. Presently there is no criteria available to determine the length of time that such a shortage can exist without irreversible damage. Without such information, I am concerned that decision-makers and competing interests will continue to utilize inadequate criteria because nothing better is given to them. That can only occur to the detriment of fish and wildlife.

Define the Purpose of the Request

One of the most difficult items for the decision-maker to relate to is an adequate definition as to what the proposed instream flow is to accomplish. When data is obtained and analyses developed, the end result should be explained in terms that are descriptive of the intended use of water. Many of the results presently coming from instream flow methodology only describe one parameter--habitat. Yet the instream flows are really being sought for fish and wildlife purposes. Most decision-makers to whom such an analysis will be presented realize that habitat is only one parameter necessary to sustain fish and wildlife. The next step necessary after the biologist has collected data on habitat is to reach a conclusion, based on water quality data, food availability, and other items as to what the described flow will accomplish. Is it designed to provide a self-sustaining natural fishery? Is it designed to reproduce natural flow conditions? Is it designed to provide a put-and-take fishery? What species of fish will the requested flows support, etc.?

Idaho has recommended in the Draft State Water Plan that the Idaho Department of Fish and Game define on a statewide basis the objective to be accomplished on each stream or stream segment. There isn't sufficient water to accomplish maximum objectives on every stream reach. If a coordinated, integrated, areawide plan identifying objectives for each stream can be identified, the decision-maker would feel more comfortable about decisions regarding a specific instream flow request.

Instream flow needs are an important use of water. The next few years are going to be critical years for instream resources. The success of efforts to obtain the necessary allocation of water will depend upon how those requests are presented. Data and analysis must be presented that will relate to the prospective of those making the decisions. Other competing interests have already developed that technique--instream flow interests must also.

DATA RETRIEVAL CONSIDERATIONS

Robert A. Longenbaugh
Assistant Professor of Civil Engineering
Colorado State University
Fort Collins, Colorado 80523

ABSTRACT

All the planning and management decisions concerning the amount of water required to maintain instream flow needs will require some type of data upon which to base the decision. This data must be readily available at reasonable cost and in a form which can be directly used by computer modeling programs or displayed in a fashion to facilitate administrative decisions.

Data can be stored on magnetic tape, in a data base management system or in some instances, captured and maintained in a machine readable form. Data must be pre-processed to assure its validity, quality, and reliability. Forethough is needed to assure that different kinds of data are compatible and that all the data required to operate a particular model are available.

Standardization of data collection within a state, drainage basin or other political subdivision is essential. This must include the kinds of data collected, the accuracy of the data and the method of reporting.

INTRODUCTION

The importance of data in evaluating historic levels of flow, water uses, water rights and to develop river basin, state or regional water plans has been addressed numerous times during this conference. Other presentations have illustrated the many different types of data required to operate some of the sophisticated computer modeling programs to simulate the biological activities in a stream, conjunctive use of surface and groundwater, optimal allocation of an area's water resources, multipurpose reservoir projects and finally, economic models which have political, social and legal constraints.

One often hears that the use of a particular model is dependent upon the availability of good reliable data in a format that can be directly processed by computers. Many of the models have been developed using hypothetical data or without considering the availability of specific data needed in the programs. It is one thing to develop a model, but its use may be limited by data availability. Models are sometimes developed and verified using data from research watersheds, where the amount of data collected and available may be much greater than for any other part of the drainage basin. Application of the model to other areas in the basin may not be possible because of data availability.

The time, personnel costs and computer costs required to prepare and process data needed for many of the computer models is quite significant. In some instances different types of data may be stored in computers at different locations which must be retrieved and reformatted in an acceptable format for a specific program. Examples of this would be use of climatological data from the U.S. Weather Bureau storage center at Asheville, North Carolina; gaging station records from the U.S. Geological Survey data bank at Reston, Virginia; and retrieval of water quality data from the U.S. STORET system in Washington, D.C. Data from each of these storage facilities can be provided on magnetic tape but the time to retrieve the data may be prohibitive. The magnetic tapes may not even be compatible with the computer at the point of use and decode and reformat programs are usually needed to process the data prior to its use in the models.

THE COLORADO WATER DATA BANK

The State of Colorado committed itself to develop a data bank to collect all water related data for the entire state at a single location where the different types of data would be compatible. Types of data to be included are: water rights, diversions, reservoirs, wells, stock ponds, dams, gaging stations, snow courses, climatology and water quality. For some types the data will be descriptive in nature. However, data on reservoirs, gaging stations and diversions will be both descriptive and numeric. Numeric implies that an amount is observed on a particular date as compared to descriptive which might be a name, address, date or legal description. Computer storage problems may be different if the data is numeric or descriptive or mixed. A data storage definition must be selected to minimize the storage space while still providing flexibility for retrievals. A complete definition of all parameters to be considered a part of the data record for each type of data must be determined at the outset.

The State of Colorado felt that ready access to all water data at a single site was necessary to provide the information needed to administer the state's water on a day to day basis. Examples of decisions that must be made include the amount of water that can be diverted at each point considering each canals water rights, the amount of water that must be allowed to pass out of the state to satisfy river compacts, the granting or denying of well permits and the corresponding impact such wells might have

Table 1. Types of data to be initially placed in Colorado Water Data Bank with indication as to whether it is descriptive, numeric, or both.

Type of Data	Descriptive Data	Numeric Data
Water Rights	37,000 Records	--
Reservoirs	2,200	30 years historic monthly & current
Dams	2,500	--
Gaging Station	530	Daily values for entire record
Diversions	12,000	30 years of historic daily & current
Wells	75,000	--
Climatology	248	30 years of historic daily & current
Stock Ponds	12,500	--
Water Quality	Unknown	Unknown

on senior water rights and finally, the complete accounting of water delivery from reservoirs such as the U.S. Bureau of Reclamation projects to downstream water users.

Two other reasons for developing the water data bank were of major importance: data could be made available to other outside users while still maintaining data security; Standardization of the data collected and the way it was reported was achieved state-wide. There was some resistance to standardization of the types of data collected and the reporting format but its benefits are readily apparent to all the users at this time. This standardization also provided a mechanism for a more detailed accounting of the water used.

Another objective which has been reasonably achieved at this time was to develop the capability to cross reference the various types of information. For example, it was desirable to be able to retrieve all the water rights for a particular canal and at the same time retrieve the daily diversion records which would provide an accountability of how the water was used. In many instances, the accumulated flow rate granted by the water rights far exceeds the historic diversions and may even exceed the canal capacity. A unique set of identification numbers were assigned to all water use, delivery, storage or measuring points throughout the state. The method by which the identification numbers were assigned provides the capability to retrieve certain types of data such as just the records for canals, reservoirs, or wells. The cross referencing is accomplished by inserting these identification numbers in the corresponding descriptive records such as water rights or dams.

The Colorado Water Data Bank contains both historic and current information. Table I above lists the amount of record which is included. New records are added as they become available, i.e. new water rights, diversion records, reservoir storage, and new dams or stock ponds.

THE WATER DATA BANK SYSTEM

A system is needed for capturing, verifying, correcting, updating, and retrieving data from a data bank. Certainly the success of a data bank is largely dependent upon its useability which is directly related to the retrieval capability. Users must be able to obtain the desired data rapidly and at a reasonable cost. The actual format of the data may limit its retrievability. It is usually desirable to have a record format which will allow you to select a subset of the total data and then input those records to another program such as a computer model, statistical program or graphical output device.

Data must be processed prior to its final loading to a data bank to assure its validity and reliability. Use of machine editing to determine possible errors is desirable. If data is collected manually, then a human interface in the verification process is normally needed. Forethought in developing data capture, verification, correction and update procedures can significantly affect the cost of obtaining good data. The use of mark sense forms, portable keypunches, cassette data capture machines and interactive terminals is now being promoted as a means to capture data and at the same time reduce time lags, reduce capture costs and increase the reliability. The success of a data capture program is highly dependent on the data capture mechanism.

DATA STORAGE

As mentioned earlier, the success of a data bank program is closely related to its useability and cost. Both the useability and cost may be related to how data is stored. Keypunched cards was one of the first mechanisms used to store data. Magnetic tapes which can be read easily by computers and require a small amount of space for storing a large volume of data are now used extensively. If access to the data is only occassionaly and the cost to scan an entire tape or series of tapes is not prohibitive, then magnetic tapes are a quite acceptable storage mechanism. The use of disk storage or mountable disk packs should be considered for larger volumes of data where heavier use of the data is required and random access to specific files is anticipated.

The development of computer data base management systems (DBMS) has been rapidly changing over the past ten years. The systems have increased in their complexity and sophistication. The DBMS generally provides a complete capability for processing data into and out of the machine. Most of the systems now provide some editorial capability and various levels of sophistication in retrieval and reporter modules. Some of the packages actually contain graphical output devices that display pictures on a line printer, on a vacuum tube, or even converted to microfilm.

Some of the DBM Systems store the data in the original record format and operate on a sequential search principle. The more sophisticated systems will provide random retrieval on certain preselected fields. This shortens the retrieval time and permits a user of the data bank to qualify the types of retrievals. A random retrieval DBMS requires additional computer storage to include the pointer information which is assigned by the machine. Some DBMS completely invert the data file (all the parameters in a specific record can be treated as keyed fields and random retrieval is possible on any parameter) while other systems invert only a portion of the data, and thus random retrievals are possible for only the key fields. A disadvantage of the fully inverted DBMS is that the entire record is decomposed and thus retrievals can be made only through the DBMS. Some of the partially inverted systems such as MARS VI of CDC will allow access to the data through standard FORTRAN or COBOL programs to the sequential record file.

Experience on the Colorado Water Data Bank Project has indicated that random retrieval by qualifying the retrieval is essential and will permit quick access at reasonable costs. Experience also indicates that a fully inverted file is not necessary. The items included in the Colorado Water Data Bank as key fields include a code to designate the principal drainage basins (referred to as divisions and there are seven in Colorado), a smaller subset of the principal drainage basins (referred to as a water district and there are 80 in Colorado) and the identification number. Each of the record types described before is treated as a separate data base and in some instances both a numeric and descriptive data base are created for each type.

The Colorado Water Data Bank uses the MARS VI DBMS and information on the system and its useability can be obtained by contracting the Colorado Division of Water Resources, Room 300, Columbine Building, 1845 Sherman Street, Denver, Colorado 80203. The project required three years in the development stage and over $650,000 was spent to develop the procedures, techniques, computer programs and documentation. Part of this expenditure also included capture of both historic and current data. Some further development is needed to include information for all types of data. Currently, records are available for diversion, water rights, reservoirs, gaging stations, and climatological data. Well records still reside in another system. Current expenditures total about $150,000 per year to maintain computer support staff, provide staff to process current and historic data and to cover the computer cost of processing the data to the data bank. In addition to the use of the data bank by the Colorado Division of Water Resources, it has been used by municipal and county governments, consulting engineers, lawyers, private citizens and some land use planning groups.

ANALYSIS OF WATER AVAILABILITY FOR ENERGY DEVELOPMENT

In an effort to demonstrate how the Colorado Water Data Bank could be used with existing hydrologic models, a project was funded by the Federal Energy Administration (FEA) with the Colorado Energy Research Institute. Work on the project is being conducted at Colorado State University with a project completion date of June 30, 1976. Workshops or symposiums are anticipated to allow participants to gain first-hand experience with the Colorado Water Data Bank and a series of hydrologic programs which have been selected to provide information to planners on the proposed impact of energy development on water. The White River Basin in western Colorado was selected as a prototye study area.

Results from the FEA project to date include:

1. Data from the Colorado Water Data Bank can be retrieved and used as direct input to hydrologic models
2. Some of the sophisticated water models cannot be used because data does not exist
3. Analyses can be made to determine virgin river flows and current uses

4. Programs and data are available to evaluate what would be the impact of minimum stream flow standards, large diversions from the stream for production of oil shale or coal and the change in flow patterns associated with a change from a predominantly agricultural use for irrigation
5. Some additional structures must be built to provide a dependable supply for either the oil shale or coal industries. These structures would also be necessary to provide some minimum flow regulation capacity
6. Some human interface in the modeling and water administration and planning process is essential
7. Use of computers for both storing the data and running the water models is essential and could not be handled manually.

SUMMARY

Computers are essential to provide and manipulate the large volumes of data and operate the models which are necessary to help administrators and planners make the best use of our limited water resources. Data is not always available to answer the questions or update the sophisticated models. Standardization of data is essential to provide data that is compatible and accurate.

Computers for storing data and operating computer models should not be used blindly without considering the user and his needs. Scientists, engineers, lawyers and politicians all have a responsibility to work closely with computer personnel to assure that data is provided when needed and that the results from models actually can be interpreted in a certain way.

TOPIC II-C.

DATA NEEDS FOR PROTECTING IFN

Summary Discussion

Questions directed to the panelists involved the following:

Burkhard (Biologist)

1. The acceptability of the data in Colorado--there is need for standardization within USGS and USFS methodologies;
2. Were fisheries the only criteria? What about riparian values?
3. When will recreation and aesthetics be more fully included in the methodology? We work primarily on the hydrologic profile, including riparian features only when we are familiar with them. Aesthetics and recreation may have stronger determining power in the future.
4. Can we approrpiate more than the flow of the river? Yes, all appropriations given after 1906 in Colorado are for unavailable waters, but the transfers and trade-offs available allow junior users to obtain water.
5. Do we gather data to present an optimum of minimum flow? We request a calculated minimum flow or the natural minimum, which ever is higher. Optimum flows are listed as guidelines.

Allred

1. Do you put a dollar value on fish? No, very few decisions are made by B/C analysis. Mostly on the benefits received.
2. What are the largest administrative problems? We focus on milestones, not goals. We must be the leader, not the reactor.

Comment: Biologists interests have been divergent from those of the decision maker.

Data needs can best be satisfied by the following guidelines:

1. Collect reliable data by increasingly standardized methods.
2. Recognize the needs and responsibilities of decision makers. Can they sell your program on hard facts or aesthetics?
3. Create proper analogies, ones which support correlations between dewatering and not only fish loss, but also personal and private damages, losses of aesthetics.
4. Create data interpretation experts; testifiers whose credibility is accepted by both judge and jury.
5. Be aware of and use proper data retrieval systems.

Notes by panel moderator: Charles G. Prewitt
Steering Committee Member

FLOW STABILIZATION AND FISH HABITAT

George J. Eicher
Portland General Electric Company
Portland, Oregon 97205

INTRODUCTION

Stability of flows in streams inhabited by resident fish, particularly salmonids, is normally beneficial. In the case of spawning areas, it is quite desirable to maintain a constant depth of water over redds as well as uniform passage of oxygen-laden medium through the gravel. Stable temperature in a proper range is also beneficial, particularly in the case of cold-water fish such as salmonids where it is improved by cooler summer flows and warmer ones in winter. In some instances, flow stability may pose problems, particularly in cases of heavily-silted streams which continue to receive silt after flow stabilization is achieved, inasmuch as scouring by floods can be expected to move silt on downstream. Some are of the opinion, however, that this is not entirely a good thing. Flows which move silt on down usually also bring more silt in from upstream so that no net gain accrues. High and rampant flows, of course, frequently are damaging to fish, particularly to young and eggs in the gravel.

We often hear biological purists erroneously state that the medium in which a species has existed for many generations is the best for it because it has become adapted to it. The fact that an animal has managed to survive under certain conditions is no indication that it will not respond favorably to better ones. We have innumerable examples of habitat changes which have resulted in greatly increased populations of better fish. I would like to cite a few examples.

Sockeye Salmon in Bristol Bay

Sockeye salmon spawning grounds in the Bristol Bay area of Western Alaska fall into three general categories. (1) Beach areas of lakes in which the fish spawn in shallow areas of the lakes themselves, in localities where upwelling springs provide fresh water and oxygen to eggs. (2) The most prevalent type is the runoff stream, one which reaches from a lake far up into headwaters of distant hills and is subject to the vagaries of weather producing precipitation that maintains the bulk of the flow. This type of stream supports the major portion of Bristol Bay spawning. (3) Streams connecting lakes. Such tend to be short and rather stable in volume and temperature compared to the other types. Possibly 25 percent of the Bristol Bay spawning grounds are of this type. In a paper I delivered to the Fourth Alaska Science Conference in 1953 titled, "Differential Productivity of Bristol Bay Red Salmon Spawning Grounds", I compared the relative productivity of these three types. My findings were that the streams connecting lakes were by far the most productive in terms of numbers of spawners returning and also the most consistent in size of returns from year to year. Although it is difficult to compare characteristics of lake beaches with flowing streams, such areas are subject to widely varying conditions from year to year in temperatures and upwelling springs. The basic difference, of course, between streams connecting lakes and runoff streams is that the former are more stable in terms of flow, temperature and turbidity. The coefficients of variation, which are inversely proportional to consistency of return, for 70 of the most prominent Bristol Bay spawning grounds including 18 beaches, 25 runoff streams, and 27 connections, were 78.4 for runoff streams, 71.8 for beach areas and 52.9 for connections - thus indicating that the connections were much more consistent. It was also noted that average returns over a 10-year period were sufficient to utilize 26.4 percent of the beaches, 40.7 percent of runoff streams, and 52.4 percent of connecting streams, thus indicating the comparative size of returns. It was not possible to show that steady production of connecting streams was much better than the other types of spawning areas in years of overall poor production. In many years on some systems the only returns of effective numbers were to this type.

Deschutes River

Although the Deschutes River in Oregon has been historically a fairly stable stream, it has also suffered from siltation by a type of fine material that tends to cement interstices in gravel, thus reducing spawning ground value as noted in the Special Scientific Report Fisheries #39, "Survey of the Columbia River and its Tributaries" by Reed S. Neilson, 1950, and several Oregon Game Commission Annual Reports in the 1950's.

Construction of the Pelton and Round Butte developments in the late 1950's and early 60's has markedly stabilized flows and temperatures and reduced silting in the stream. The result has been increased spawning by salmon and steelhead in the main stream immediately below the project which has been spreading downstream since that time, a condition that also held true in the main stream of the Columbia River immediately downstream of Chief Joseph Dam until inundated by the Wells Project.

Colorado River Below Hoover Dam

Before construction of Hoover Dam on the Colorado River, this general area was habitable only by warm water species of fish. It was subject to widespread variations in temperature ranging from the low 40's F. to the low 90's F. Flow volumes also fluctuated from low minimums to massive floods, and a continually heavy silt load was evident. After filling of the Hoover Dam pool by Lake Mead, flows were stabilized to the extent of hydroelectric peaking immediately downstream of the project. The water became clear and the temperature range reduced from something over 50 degrees F. to less than 5 in the low 50's. It became relatively uninhabitable by previously prevalent warm water species such as catfish, bass and the large Colorado River squawfish but became prime trout water. In the paper, "Colorado River Trout Fishery" from Arizona Wildlife and Sportsman Magazine, December 1946, I described planting marked rainbow trout, which were culled hatchery "runts" rejected from normal usage and which within twelve months grew from an average of five inches to one of 18. It should be added that

Colorado River water at this point has other things going for it than mere stability, however. Chemical composition and food supply emanating from Lake Mead are outstanding.

Sacramento River Below Shasta Dam

When Shasta Dam was being constructed in the late 1930's, it was predicted by many biologists of the area that salmon production of the Sacramento River as a result of the project's cutting off over 50 percent of the available spawning area would be reduced by at least this amount. Fortunately, this did not occur. Coversely, following completion of the project, stocks of salmon increased in the spawning area downstream to far exceed that obtained from upstream areas previously. This is one of the prime examples of beneficial effect of flow stabilization. Prior to the project, Sacramento River temperatures at Redding a few miles downstream of the project, ranged from approximately 32 degrees F. in winter to extended periods of well over 80 degrees in summer. Obviously salmonid spawning and rearing conditions in this river were untenable. Project construction resulted in shrinking this 50 degrees F. range to less than 10 centered in the 50's. This ruined swimming by people but did two things for salmon production. It made the river habitable for both spawning adults and rearing young in summer and promoted fast growth of young in winter. Scouring of the spawning grounds was virtually eliminated and siltation of the beds virtually halted. The result was a constant cleaning action in the gravel farther downstream each year until a great many miles became prime spawning areas. Another benefit for rearing salmon was the heavy production of food in the upstream reservoirs, principally in the form of plankton which carried through to the spawning and rearing areas downstream.

As the result, spawning in the main stem in this area not only was now possible but feasible in all portions of the year. Spring, summer and fall runs rapidly populated the areas farther downstream each year and covered more of the calendar until now spawning occurs in every month of the year and the three runs overlap to the point where they are virtually indistinguishable.

Willamette River in Oregon

In recent years we have seen a great deal of copy in the media with respect to improved water conditions in the Willamette River which has resulted in greater production of salmonid fish, both in tributary and mainstream spawning. An oxygen block in the Portland harbor, which in earlier years often saw the level drop virtually to zero, has not been below five ppm in the last half dozen years. Although virtually everyone has given credit to Governor McCall in the past five years or the Oregon pollution control agency over the past 50 for accomplishing this, a quick look at the data indicates that the source is probably elsewhere. Although the Oregon Sanitary Authority and its successors over the past 50 years has done a remarkably efficient job of reducing pollution by both municipalities and industry, it can with a degree of safety be remarked that the dominant factor in enhancement of salmonid habitat has been flow stabilization provided by storage projects, principally by the Corps of Engineers on tributaries to the Willamette River.

In the 1920's when every municipality on the Willamette River was discharging raw sewage to it, minimum flows well below 3,000 cfs were common. Pulp and paper mills and canneries discharged large quantities of oxygen consuming waste. The combination of low flows, high temperatures and heavy BOD in late summer and fall, resulted in the almost total lack of oxygen. Since institution of the Corps' water storage projects, however, summer flows have been gradually increased, particularly over the last seven to 10 years and now minimum flows are seldom allowed to fall below 6,000 cfs, over double the natural ones. Water discharged from storage in late summer has not only doubled the minimum flow, but it has done so with relatively cold water able to hold the oxygen picked up a short distance downstream, the net result being a colder and more oxygenated Willamette River even in the lower reaches. Not only are salmon able to proceed upstream through the Portland harbor and over Willamette Falls at any time of the year, but spawning and salmonid rearing is also possible the year around in the main stem.

Many similar examples exist elsewhere. I have cited these in particular because they happened to be some with which I had personal experience in some degree.

THE THERMAL POWER PLANT
A VERY REGULATED WATER USER

Kenneth R. Wise
Washington Public Power Suppply System
Richland, WA 99352

ABSTRACT

Because of the size of each project and the associated public interest, thermal power plants receive unusual regulatory agency attention. The vigor of this regulatory process may be indicative of the future for other water users.

Thermal power plants receive needed permits following exhaustive hearings and deliberation on a case-by-case basis. Additionally, there have been comprehensive hearings and rulemakings, particularly by the Federal government, which establish conditions which such plants should reasonably be called upon to meet.

Out of these processes has come an improved awareness of solutions to pollution problems and a somewhat clarified direction for people proposing to do things as to what standard they should meet. In general the builders of power plants in the Northwest are developing proposals that comply with these guidelines.

Licensing of such plants in the past has taken the form of confrontation between applicants and regulators. The public will be best served if the process continues to evolve towards the setting of reasonable and practical guidelines which both applicants and regulators follow.

INTRODUCTION

Regional Energy needs have until recently been met by hydroelectric generation, which results in an instream flow need. As we face our energy needs for the remainder of this century it is apparent that more thermal generation is required. The heat rejection from such facilities requires water, either to cool the condenser directly, or more typically now, to satisfy the consumptive requirements of evaporative cooling systems.

So energy finds itself on both sides of instream flow considerations, as needing instream flow to support hydro-generation and as a user requiring diversion or withdrawal to support thermal generation.

I would like to pause for a moment and put into perspective the water user that we are talking about, the thermal power plant, to make this a little more relatable to other water users in the room. Let's talk about a typical power plant of the vintage being constructed today. Let's have it be a two unit nuclear power plant generating 2500 megawatts electric and using evaporative cooling. This water user will require withdrawal of somewhere between 70 and 100 cubic feet per second depending upon the meteorological conditions at the site and will return 10 to 30 cubic feet per second of this water to the stream, depending upon the water quality. If I take a short step and assume irrigation with three acre feet per acre over a 6 month season and compare these water uses on a daily or peak basis, the thermal power plant that I have described will require withdrawal of enough water to irrigate 10,000 acres. About 80% will be evaporated and the other 20% returned to the stream. If it were a fossil power plant, it would consume about 16 percent less.

REGULATORY PROCESS

The regulatory process for either fossil or nuclear power plants is a highly visible process. While water withdrawal permits are an important part of the regulatory picture, discharge permits seem more constraining at present. Some other industries are also finding discharge permits quite restrictive, while concern for return flow water quality is still developing for other user categories. For power plants there are numerous and seemingly endless public hearings where the regulatory agency hears extended detailed discussions and judgments regarding potential for effect from the Applicant's proposal. Usually the vast majority of what they hear comes from the Applicant's witnesses with some input from members of the general public and occasionally input from an organized intervenor. These hearings proceed on both Federal and State levels and are generally duplicative of one another.

Traditionally regulating agencies have found themselves under considerable pressure from many sides to issue permits. Also, Applicant proposals traditionally have in some cases been kind of bare boned environmentally and the Regulatory Agency has been forced to constrain various project features.

Effluent Guidelines

On another related front, in recent years there have been protracted rule making hearings, particularly with regard to effluent limitations in response to the Federal Water Pollution Control Act of 1972. These rule making hearings have been very much in the public arena and at the conclusion of these rule making hearings the EPA has applied their discretion and reason based upon the extensive hearing record. They have applied a balancing process. Many people disagree with the regulations that they came up with but that is beside the point relative to my discussion today. It would appear that the agency's staff has tried to balance and put in perspective all of the knowledge they have obtained from that hearing process as well as from their own staff appraisals and development documents. At the conclusion of these hearings EPA has then set effluent guidelines for each kind of source. For nuclear power plants the Nuclear Regulatory Commission has developed similar regulations most notably the Appendix I to 10CFR50 which deals with keeping the discharge of radionuclides "as low as practicable". Most people in this room are probably quite familiar with the effluent guidelines for their particular industry.

Before I proceed further I wish to make it clear that I believe that as a whole the regulatory agencies that I'm speaking of are staffed with conscientious people who are honestly attempting to administer their interpretation of the laws their agencies are chartered to uphold.

Economic Vulnerability

Power plants, because they are capital intensive and with the escalation and inflation that is taking place in our economy today, are vulnerable to excessive delay in the regulatory process. For example, if the construction of this two unit nuclear power plant that we have been talking about is delayed for one year, the final cost of having the facility in place will increase about $100 million or five percent. The Applicant proposing to build such a power plant, whether it is a private company or a public agency, is under considerable pressure to do what it can to encourage dispatch by regulatory agencies. This provides regulatory agencies with considerable leverage to ratchet an Applicant into commitments for capital equipment or operating constraints. Again whether the Applicant is a public agency or a private company, these organizations have realized that the proper avenue to take is to include the necessary provisions to minimize the environmental effects of the power plant that they are proposing and make the proper environmental features part of the original proposal. Although both private companies and public agencies seem to end up with similar proposals it is important to note that public agencies have been called upon by laws such as the Washington State Environmental Policy Act to be self-policeing and really only make good environmental proposals, to incorporate appropriate mitigating features without the traditional arm wrestling.

Examples of other laws or regulations which call on an Applicant to take this attitude are again the Federal Water Pollution Control Act of 1972 and its implementing regulations and because the regulatory agencies at the Federal level are bound by the National Environmental Policy Act, the proposal is tested by both the Applicant and the regulatory agencies against the standards found in this act among others.

Traditional Approval

Years of tradition have developed the idea that a regulatory agency is doing its job only if it is questioning, ratcheting, tightening on each and every proposal. When has a regulatory agency said that an Application is really good -- and told the world about it? The answer is seldom. The problem also finds its way into the applicant's house. He finds himself forced to hold back a little something so that he can still accomplish his needs following such agency tightening. This whole mentality of ratcheting gets in the way of expeditious licensing based on facts. There should be a close relationship between the case-by-case requirements laid on a specific proposal and the effluent guideline regulations. Effluent guidelines should be the yardstick against which an applicant is measured. Lets reflect on what the agency charged to establish such effluent guidelines attempted to determine in establishing these guidelines. They have, to the best of their abilities, made a studied balance of the capabilities of technology, the costs of applying such technology, and the environmental benefits to be expected. Almost everyone will agree that when they have errored they have consciously done so in the direction of assuring the protection of natural resources values.

I would like to spend a few moments on some examples where I judge that the regulating agency ratcheting attitude from the past seems to still be part of the way of thinking of these agencies. My conclusion will of course be that this way of regulating should give way in this era of improved responsibility on the part of Applicants.

Hanford Generating Project

The first example is with the Supply System's Hanford Generating Project. This is an 860 megawatt electric generating facility which is located adjacent to and uses steam from the Energy Research and Development Administration's N Reactor. It is located north of Richland, Washington along the Columbia River. Unlike the example I talked about previously which used cooling towers, this plant, which has been in operation for about ten years, uses once through cooling for condensing the steam from the turbines. It therefore has a non-consumptive withdrawal requirement of about 1300 cubic feet per second.

Pressure is anticipated at the time of NPDES permit renewal to provide evaporative cooling for this facility.

EPA's effluent guidelines for steam electric power plants makes specific provision for older facilities such as this and in fact such older facilities are excluded from the effluent guidelines. Discussions with regulatory agency staff suggest that they think we should go beyond these effluent guidelines and meet State water quality standards at the edge of the mixing zone which is so small that it would preclude once through cooling and require backfitting with cooling towers. There is considerable information demonstrating that there are minimal aquatic effects due to the operation of this plant. In fact considerable data on the rejection of considerably greater amounts of heat when the Atomic Energy Commission was operating nine plutonium production reactors in the same area also shows minimal, if any, effect.

WPPSS Nuclear Projects Nos. 3 an 5

The second example I would like to turn to is with regard to the Supply System's Satsop site, west of Olympia, again in the State of Washington. In this case the State of Washington Energy Facilities Site Evaluation Council is taking steps to require the Supply System to attain zero discharge of liquid radioactive materials. Notwithstanding Federal preemption of this subject, the Nuclear Regulatory Commission held extensive hearings leading to regulations numerically defining and requiring releases "as low as practicable". The Supply System designed the planned facilities to do at least that well. A considerable hearing record was developed in front of TPPSEC which demonstrated that the plant had facilities which might indeed be able to attain zero radioactive discharge for extended periods of plant operation. There was and still is some uncertainty with regard to the ability of the plant to operate for the total plant operation period which could be 50 years without having some unforseen incident which would increase the plant's water inventory to the point that some water would have to be discharged, only following treatment and only under carefully monitored conditions. The Supply System has an attitude of always wanting to fully disclose that such events are to be anticipated and should be considered in the initial licensing of a plant. The Supply System has agreed and of course is required to meet whatever applicable standards exist or are developed in the future. This regulatory agency, however, still judges that they should prohibit discharge of radionuclides at any concentration.

These examples of regulatory agency zeal above and beyond the applicable regulations of companion agencies are suggestive of difficulties all water users can anticipate.

Conclusion

There is a very real need for regulating agencies to be able to say "yes" to a good proposal without being defamed for being "in bed with industry." Laws like the State of Washington State Environmental Policy Act (SEPA) call on public utilities to be essentially self-regulating, self-policeing in environmental areas. Private utilities also have incentives to proceed in much the same manner.

If an applicant has in fact responded to these laws (SEPA) and developed a minimal impact, well balanced proposal, and if the applicant has developed a proposal in compliance with the appropriate effluent guidelines, the licensing process should proceed quickly towards a permit consistent with the original proposal. Losing sight of the past rulemaking, the compliance with already tight effluent standards in original applications, and continuing to regulate on an ad hoc basis is resulting in substantial delays in development of the energy resources of the Northwest. Other industry such as large irrigated farms as an example is or soon will be having similar difficulties.

If our institutions would rather move towards the goal of acceptance and prompt approval of good proposals, those in compliance with applicable guidelines, our society and environment will be better served.

FISH PROTECTION AT IRON GATE DAM
KLAMATH RIVER, CALIFORNIA

J.A.R. Hamilton
Pacific Power & Light Company
Portland, OR 97204

The Klamath River was first used for the generation of electricity with the construction of two small hydroelectric projects, one on each side of the river near Klamath Falls in Oregon. This was followed by the construction of Copco Dam and Copco Powerhouses 1 and 2 in California (Fig. 1). John C. Boyle Project was built in Oregon in 1958. The latest of the hydro facilities was completed in 1962. This is the lowermost project, known as Iron Gate.

Iron Gate Dam, located about seven miles below Copco, was built and is operated as a flow reregulating dam. Prior to its construction, California Fish & Game and California Oregon Power Company (predecessor to Pacific Power & Light), conducted studies in the Klamath River below COPCO Dam. The COPCO projects since their inception have been used as peaking plants as well as energy producers. This peaking resulting in daily and weekly fluctuations in river flow and river stage. Both California Fish & Game and California Oregon Power Company demonstrated that numbers of juvenile salmon and steelhead were stranded and killed as a result of these fluctuations. The matter was referred to the Federal Power Commission, and as a result of its findings and deliberations between the parties, a decision was reached to build Iron Gate Dam. Reregulation could have been accomplished at the COPCO projects, but this would have involved two power plants and would have adversely affected the power potential of these plants so Iron Gate Dam was built as the flow reregulator.

Iron Gate Dam is about 160 feet high (Fig. 2) and creates a reservoir about seven miles long with a total capacity of 58,000 acre-feet. The powerhouse has one generating unit with a capacity of 19,000 KW. The dam has an open non-gated spillway.

The Klamath River above the Iron Gate Dam site and below COPCO Dam and several small tributaries were spawning and rearing areas for fall chinook and steelhead. The field surveys of California Fish & Game indicated that between 6,000 and 7,000 chinook and an undetermined number of steelhead used the area and that compensation in the form of fish collection and fish propagation facilities would be needed.

Accordingly, a fish collecting facility consisting of a 20-pool fish ladder, a fish collection or sweep pond, circular holding ponds and a fish spawning building were provided (Fig. 3). The entrance to the fish ladder is provided with auxiliary flow pumped from the tailrace. Fish pass up the fish ladder to the sweep pond where they collect. Several times a week the fish are cleared from the collection pond with a mechanical sweep into a tranquilizer tank in the egg-taking building. There the fish are narcotized, sorted and placed in one of the channels that leads to one of the circular holding ponds. They remain in the holding ponds until they are ready to spawn. The fish are then returned to the tranquilizer tank via the sweep pond, are spawned, and in the case of steelhead, returned to the river, and salmon disposed of. Air pressure is used for spawning the steelhead. The salmon are stripped of their eggs in the usual manner with an incision into the abdominal cavity.

The Iron Gate Hatchery (Fig. 4) consists of an egg-incubation building with 135 Heath incubators and a capacity of about 13,000,000 eggs. It is provided with a water recirculating system but does not contain any water purification equipment. Other hatchery facilities include 32, 10 x 100-foot rearing raceways, four in a series, office and workshops, cold storage facilities, and four residences.

The water for the hatchery, fish ladder and fish holding facilities is drawn from the reservoir through a 30-inch line. Water can be drawn from two levels, one at 70 feet and the other at 18 feet. The water supply line connects to an aerator (Fig. 5) and is then distributed to the fish collection and holding ponds and to the hatchery. Earlier studies had shown that water drawn from deep in the reservoir was deficient in dissolved oxygen and that an aerator was essential to maintain adequate oxygen levels. The aerator has a capacity of about 45 cfs.

The fish collection facilities were designed jointly by California Department of Fish & Game and the National Marine Fisheries Service, and the hatchery by the Department of Fish & Game and Pacific. California Fish & Game operates the facilities and the cost of the hatchery operation is borne in the ratio of 80 to 20 percent, with Pacific assuming the major share.

The Federal Power Commission license for the Iron Gate Project provides a minimum flow schedule of 1,000 cfs for May and August, 710 cfs for June and July, and 1,300 cfs at all other times, providing Klamath Lake has an adequate water supply to sustain these flows. If Klamath Lake storage is below an amount that can sustain irrigation requirements, then adjustments in these minimum amounts may be made after consultation and agreement is reached with the fishery agencies. The Upper Klamath Basin is an extensive irrigation area and the amounts of water available to the hydro projects and other uses downstream is dependent on the releases from upstream. The license also provides that the rate of change in flow and stage below Iron Gate will not exceed 250 cfs per hour or three inches per hour, whichever has the lesser effect on river stage.

The river flows below Iron Gate in relation to those observed in the mid-1950's for the period April to October are shown in Fig. 6. The fluctuations which are shown here for the early years are weekly. Similar fluctuations occurred during the rest of the week but these do not show because the data presented from the published records of the U.S. Geological Survey are daily mean values and do not illustrate the daily swing in flow.

The operations of Iron Gate Dam have resulted in a fairly uniform flow during certain periods of the year. These might best be described as flow plateaus. The turbine passes a maximum of 1,800 cfs. During this time, the flow to the river is under control and regulation is maintained. When the turbine capacity is exceeded, all excess flow passes over the open spillway. The result is illustrated in Fig. 6 for April and October. Even with the turbine capacity exceeded, the reservoir provides a considerable degree of regulation.

The minimum flows have been met in almost all years since the Iron Gate Project has been in operation. The August and September period in 1973 was an exception. Because adequate water was not available in Klamath Lake, the minimum flow for August and September of 1,000 cfs and 1,300 cfs, respectively, could not be provided. Instead, the flow was maintained at about 750 cfs during these months. After September, however, water conditions made is possible to maintain the minimum flows for the rest of the period.

The Klamath River for many miles below Iron Gate Dam is a very popular fishing area for trout, steelhead and chinook salmon. The flows during the fall fishing season are of particular interest to the fishermen. Because of this interest, we send out about 70 reports each week from the middle of September to the middle of November to interested fishermen and to local news media giving the expected water flows for the next seven-day period. These reports also show the number of fish taken at the fish collection facilities for the previous week.

The Iron Gate Hatchery is an integral part of the fish management system. The hatchery has a capacity to rear about ten million chinook salmon, about

90 fish per pound, and about 600,000 steelhead smolts. The numbers of fish produced since 1966 are presented in Table 1. Chinook less than 90 fish per pound are not included. There has been a considerable increase in number of fish produced at the station since its inception.

Every effort is made to bring the chinook salmon up to about 90 fish per pound before they are released. This has been achieved. The coho are released at about 17 fish per pound. The size of steelhead at time of release has been very variable, both within the season and between seasons. The growth objective is 8 fish per pound or larger at time of release after one year of rearing, but this objective has not always been reached. Marking studies have shown that nearly four percent of the smolts will return to the dam when released at 8 fish per pound. The return rate dropped to 0.7 percent when the fish were 10 to 12 fish per pound.

There has been a substantial increase in the size of the steelhead and chinook runs since the hatchery was first placed in operation in 1962 (Table 2). No catch statistics are available, so the overall run size is not known. The fall chinook run in 1975 is the largest since 1955 when 14,000 fish were counted at the fish racks located about four miles below Iron Gate.

The operation has been quite encouraging to date at Iron Gate. The fall chinook have responded well to the flow regulation and artificial propagation. Attempts are being made to increase the size of steelhead at time of release in order to improve survival and returning run size.

One might get the impression that this project may have come about without debate or discussion. This is not true. There was considerable exchange of ideas, some bargaining and negotiation and one Federal Power Commission hearing. Out of this came a program which we believe is successful.

Table 1. Number of Fish Released from Iron Gate Hatchery

1967 - 1975

	Number of Fish Released			
		Chinook		
Year	Steelhead	Fall(1)	Spring	Coho
1967	34,700	3,462,000		82,800
1968	152,600	3,700,000		51,000
1969	387,000	4,680,000		68,800
1970	452,000	1,238,000	31,900	54,800
1971	665,000	9,643,000	48,900	90,130
1972	439,000	9,100,000	13,000	87,000
1973	520,400	4,900,000	9,300	47,700
1974	200,800	6,150,000	36,000	10,000
1975	200,000	7,090,000	- -	75,000

(1) Fish are about 90 per pound or larger.

Table 2. Number of Adult Salmon and Steelhead Counted at Hornbrook and at Iron Gate Dam

Brood Year	Number of Fish				
	Steelhead			Chinook	Coho
	Fall	Spring	Total		
1956				6,770	
1957				2,436	
1958				1,950	
1959				3,546	
1960				6,353	
1961				9,021	
1962 (1)				1,473	
1963	509	945	1,454	2,142	
1964	609	262	871	2,598	
1965	277	728	1,005	678	
1966	116	812	928	3,064	4
1967 (2)	196	103	299	2,687	79
1968	461	523	984	2,764	357
1969	152	218	370	2,930	951
1970	381	813	1,194	10,503	1,623
1971	292	2,073	2,365	10,846	146
1972	174	3,583	3,757	3,684	91
1973	226	1,060	1,286	8,729	841
1974	665	1,200	1,865	9,396	475
1975	1,033	2,165	3,198	11,180	559

(1) Start of fish collection at Iron Gate.

(2) First complete year of hatchery operation.

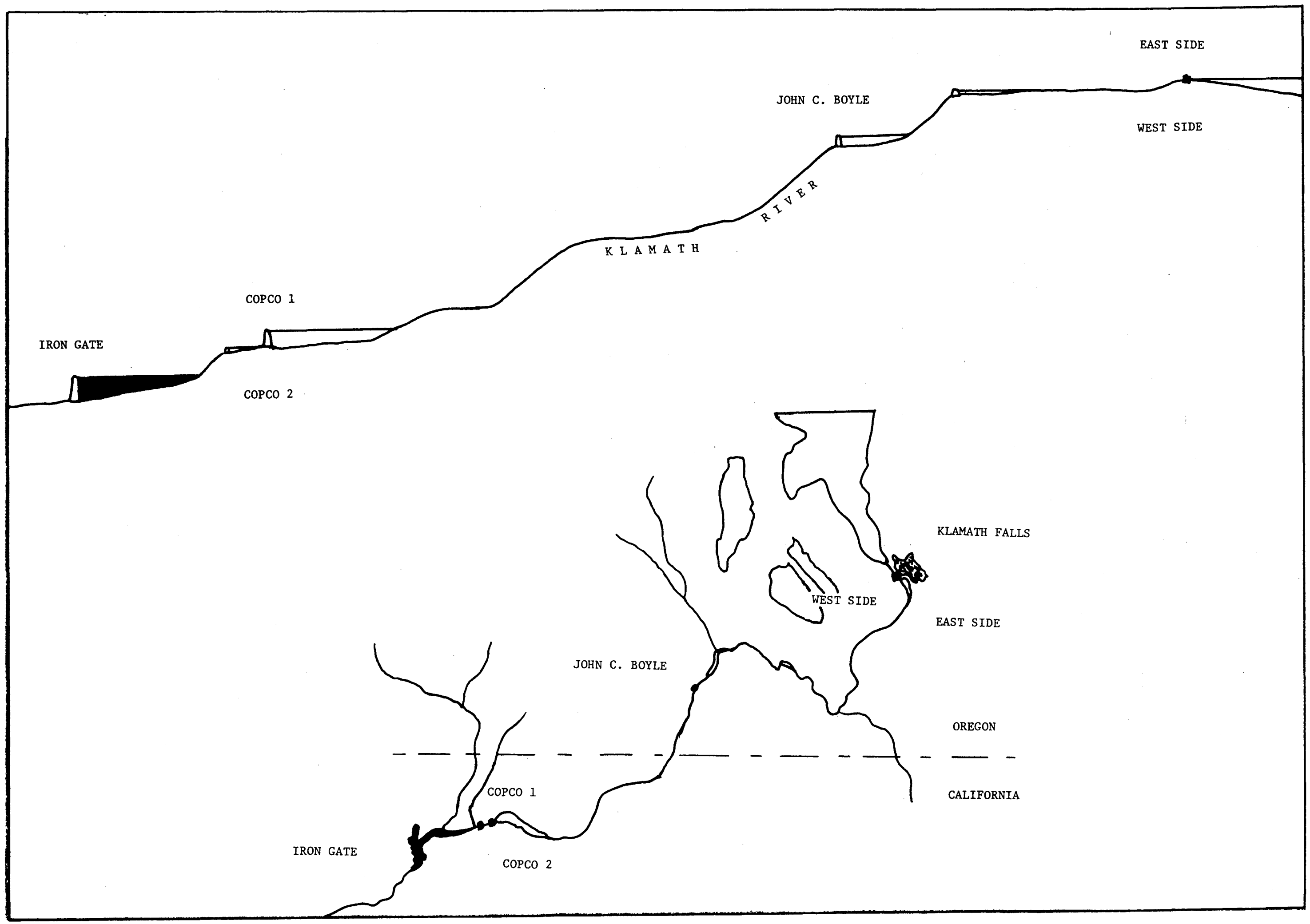


Fig. 1. Location, Iron Gate Dam, Klamath River

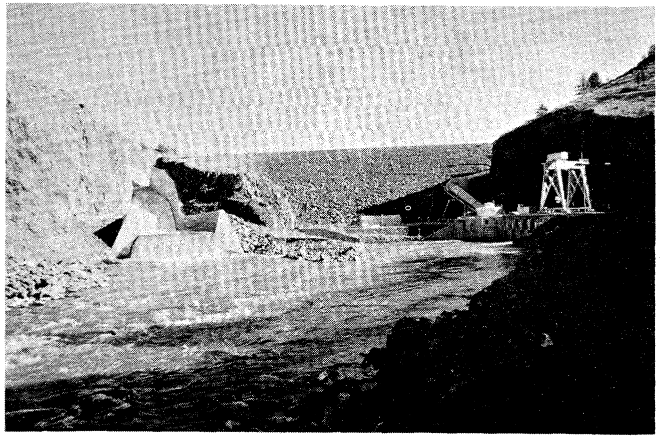


Fig. 2. Iron Gate Dam and Powerhouse

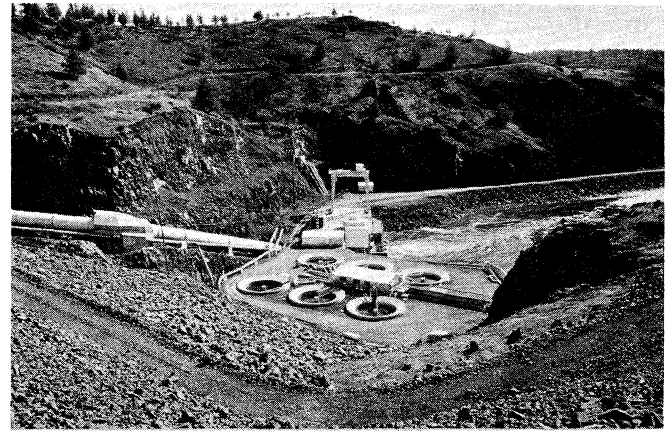


Fig. 3. Iron Gate Fish Collection Facilities

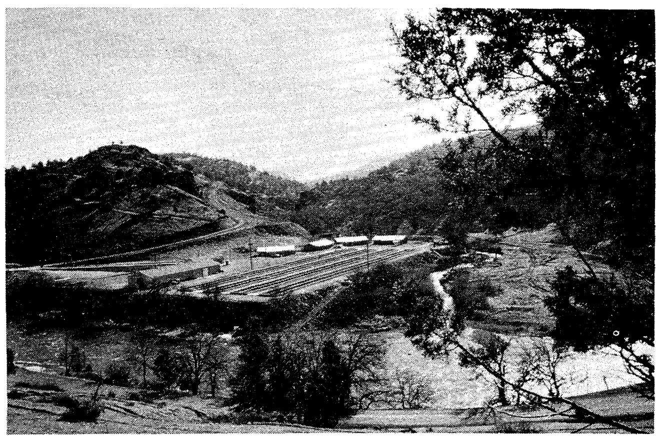


Fig. 4. Iron Gate Salmon and Steelhead Hatchery

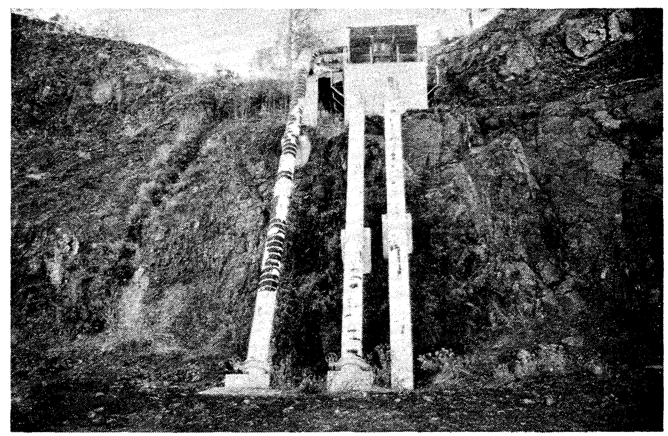


Fig. 5. Aerator

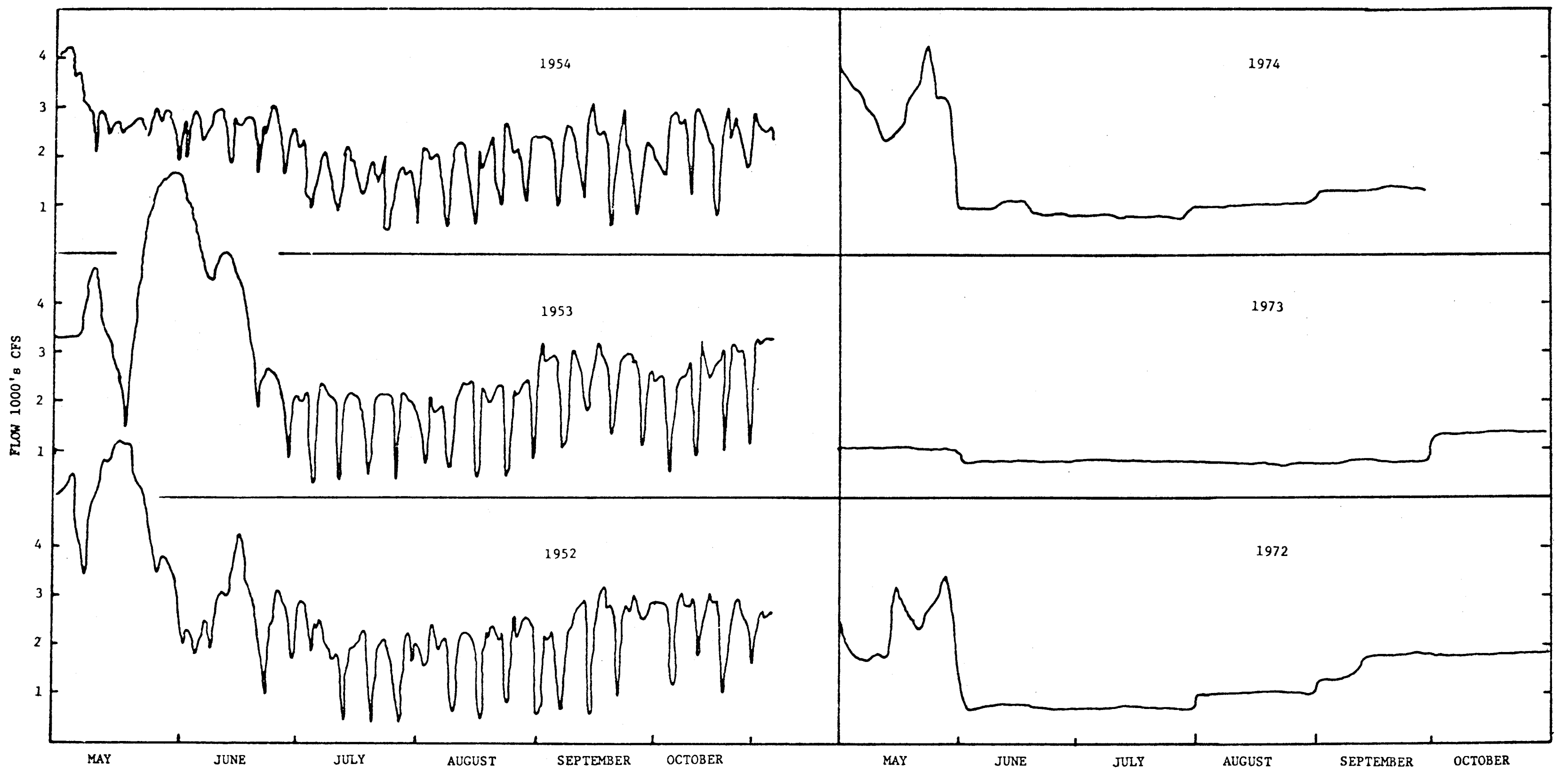


Fig. 6. Klamath River Flows Below Copco Dam (1952-1954) and Below Iron Gate Dam (1972-1974)

FEDERAL AND STATE WATER LAWS
THEIR IMPACT ON THE UTILITY INDUSTRY

Frank B. Titus
Envirosphere Company
Division of Ebasco Services
New York, N.Y. 10006

ABSTRACT

All new thermal electric generating units, and most existing units on which construction started after January 1, 1970, must meet the requirements of the Effluent Limitation Guidelines promulgated by the Environmental Protection Agency. All construction activities must also conform.

The Effluent Limitation Guidelines address thermal discharges and chemical discharges resulting from plant operation, and chemical discharges (including suspended solids) from construction.

State standards generally control water quality in the receiving water body beyond the point of discharge from a facility, and sometimes place more stringent limitations on facilities than do the federal guidelines.

The federal and state laws and regulations have resulted in fewer once-through cooling systems being planned and constructed, water management plans to minimize and control the quality of discharge water, a need to backfit water quality control facilities on some existing plants, and other changes in design and construction.

More stringent and explicit control of leachates which could affect ground water quality is expected.

As a result of the Environmental Protection Agency (EPA) Effluent Limitation Guidelines implementing the Federal Water Pollution Control Act Amendments of 1972, and of state laws and implementing regulations which usually address receiving water quality standards, the utility industry is faced with a complex set of requirements for both new and existing power plants which are aimed at mitigating aquatic environmental impacts. In this paper I will summarize the federal regulations applying to thermal generating facilities, then summarize the thrust of state regulations, and, finally, comment on some of the effects that implementation is having on the industry.

The EPA Effluent Limitation Guidelines for Steam Electric Generating Stations were issued in proposed form on March 4, 1974 and in final form on October 8, 1974. The guidelines deal separately with thermal effluents and with chemical effluents. With respect to chemical effluents, the limitations involve both runoff control and plant operating discharges. Three levels of technological application are envisioned for existing units, with individual compliance dates for each level. The levels are as follows: "Best Practical

Control Technology Currently Available", applicable on July 1, 1977; "Best Available Technology Economically Achievable", applicable on July 1, 1983; and "Best Available Demonstrated Control Technology", applicable to all new sources. The latter category comprises Standards of Performance for New Sources, and applies to all units on which construction was started after the proposed guidelines were issued on March 4, 1974. The first two categories, or levels, refer to existing plants.

Thermal Effluent Guidelines

For thermal discharges, EPA established no requirement for Best Practical Control Technology Currently Available (BPCTCA). Instead it established the Best Available Technology Economically Achievable (BATEA), and required that it apply on July 1, 1981 rather than in 1983. Under the final guidelines the affected existing units are those over 500 MW where construction started after January 1, 1970, and those over 25 MW where construction started after January 1, 1974. No other units are affected.

Basically the EPA control technology is cooling towers with blowdown from the cold side. However, for recirculating cooling systems already under construction or in operation prior to November 7, 1974, the blowdown does not necessarily have to come from the cold side. Cooling ponds and cooling lakes are not considered recirculating cooling systems, but their use is permitted if under construction or in operation prior to November 7, 1974. The Standards of Performance for New Sources applies to all thermal generating units whether large or small and simply states that there will be no discharge of heat except for cold side blowdown from recirculating systems and cooling ponds.

"Cooling pond" means any manmade water impoundment which does not impede the flow of a navigable stream and which is used to remove waste heat from heated condenser water prior to returning the recirculated cooling water to the main condenser. "Cooling lake" means such an impoundment which impedes the flow of a navigable stream.

There are a few exemptions from the thermal regulations as it applies to existing plants. These deal with special cases such as insufficient land for cooling towers, salt water towers where the salt deposition from drift may be excessive, and a case where cooling plumes would cause a substantial hazard to commercial aviation. The owner or operator also has recourse to section 316 (a) of the federal water pollution control amendments which authorizes the administrator of EPA to impose alternative effluent limitations provided that these assure the "protection and propagation of a balanced indigenous population of shellfish, fish and wildlife in and on ..." the receiving water body.

Chemical Effluent Limitation Guidelines

The chemical guidelines and standards apply to all units including old units and small units. Best Practical Control Technology Currently Available basically includes the following limitations on discharges: pH 6 to 9; total suspended solids - average of 30mg/l and maximum of 100 mg/l; oil and grease - averagy of 15 mg/l and maximum of 20 mg/l; free available chlorine from cooling systems - average of 0.2 mg/l and maximum of 0.5 mg/l. Limitations are also placed on copper and iron in the discharge water.

Best Available Technology Economically Achievable provides for additional limitations which include the following: total suspended solids and oil and grease in bottom ash transport water must be reduced by a factor of 12.5 from those envisioned in the BPCTCA, and additional limitations to cooling tower blowdown water for zinc, chromium, phosphorus and other corrosion inhibiting materials.

The Standards of Performance for New Sources have the following additional limitations: the daily quantity of pollutant discharges in bottom ash transport water must be reduced from the BPCTCA standards by a factor of 20; there is no provision for allowing discharge of pollutants from flyash transport water; and materials added to the cooling tower system for corrosion inhibition, including but not limited to, zinc, chromium and phosphorus may not be discharged in detectable amounts.

Area Runoff Guidelines

The limtations set forth in this section are the same for BPCTCA, BATAE and New Source Performance Standards, and must be met by all existing sources by July 1, 1977. They also must be met during any construction subsequent to the publication of the proposed regulations at either new or existing sources. Both construction runoff and runoff frame "materials storage" are controlled by the guidelines. The effluent limitations are: total suspended solids not to exceed 50 mg/l and pH 6.0 to 9.0, which must be controlled for a once-in-10-year, 24-hour storm.

State Standards

Although the state standards are variable, certain general statements can be made which apply to most. The usual thrust of such standards is toward maintenance of acceptable water quality in the receiving water bodies. Thus, they are usually not effluent standards (which may ignore the quality of the receiving water), but rather they establish limits on the degradation of water in the receiving water body. Thus, for the common chemical species, there may be prohibition against increasing the concentration beyond a certain percent of ambient conditions or beyond a specific maximum concentration. Toxic materials, specifically including trace elements, are limited as to maximum concentrations in the receiving water.

Thermal discharges to the receiving water body are also usually included in state regulations. A state may provide for a mixing zone surrounding the point of discharge. The dimensions of an acceptable mixing zone are sufficiently small that the mixing zone will not block aquatic migration routes or affect extensive areas that are biologically sensitive. Sampling of water to assure compliance with the standards for the receiving water body takes place at the boundary of the mixing zone. The mixing zone commonly applies to both thermal and chemical discharges. There may or may not be a limitation as to maximum temperature that can be accepted at the water surface.

Approximately half of the states have been granted authority by EPA to issue National Pollutant Discharge Elimination System (NPDES) permits. Such authority is granted after EPA confirms that state laws and regulations are consistent with the federal requirements. The NPDES permit is the vehicle by which the compliance with the Effluent Limitation Guidelines is assured. In cases where state requirements are more stringent than federal requirements, the most stringent criterion must be met by the applicant.

EFFECTS OF WATER REGULATION ON THE UTILITY INDUSTRY

In response to the federal regulations pertaining to thermal discharge, the utility industry has moved towards providing cooling towers on most new units, even those which are adjacent to a large water body which is physically capable of providing once-through cooling. This is viewed as a conservative approach by the industry in terms of obtaining a permit for a unit in that it reflects the recognition that a one year environmental study is required for a 316 (a) demonstration. Thus, the design of the circulating water system for a new unit must await the one year data collection period plus the additional time necessary for regulatory review and approval. This delay has not been acceptable to most utilities.

The 316 (a) studies, therefore, have had greater applicability to existing units. The aim of such studies must be to demonstrate to the satisfaction of the EPA Regional Administrator, or to the appropriate state agency, that no appreciable harm has resulted from the thermal effluent from an existing station, and that the protection and propagation of a balanced indigenous community of shellfish, fish and wildlife in and on the body of water can be maintained.

With respect to chemical effluents, all existing units must conform to the 1977 and 1983 limitations. Backfitting of water quality control equipment must be completed on many of these units. New units which are under the New Source Performance Standards are being designed to meet the applicable limitations. Some units that are now under construction are technically considered existing units because construction began prior to the effective date of the effluent limitation guidelines. For most of these technology is being applied which will assure that both the 1977 and the 1983 guidelines and standards will be met.

Water management plans for new units and "existing units" that are under construction have received particularly close attention. Modern water management plans commonly provide for water being recirculated through a relatively clean segment of the system, such as the condenser and cooling tower, until it must be blown down, and then being used progressively in systems which can tolerate relatively higher concentrations of dissolved ions suspended material. The effect of this cascading water use has been to minimize consumption and thereby to minimize the blowdown from the final system. This reduces the volume of water that must be treated before discharge to the receiving body.

With respect to new units, the prohibition against discharge of any suspended solids in flyash transport water makes sluicing of flyash to a disposal pond difficult unless evaporation rates are sufficently high that no blowdown from the pond is required. For coal fired plants in parts of the United States dry flyash handling is advantageous.

In order to meet receiving water standards established by the states, diffusers on discharge pipes are often necessary to assure mixing of thermal and chemical constituents close in to the point of discharge.

During construction provision must now be made to control runoff from all disturbed areas by channeling it into retention basins capable of storing the once-in-the-year, 24-hour storm runoff in order to settle suspended solids to meet the limitation of 50 mg/1. After construction has been completed provision must also be made for runoff control from the material storage areas such as coal, ash and other materials.

It can be anticipated that there will be future modifications to the water discharge limitations. Certain modifications may result from initiatives by the utility industry. The Utilities Water Act Group is involved in litigation in which it contends among other questions, that: the back fitting requirements to all plants to meet the Chemical Effluent Limitations Guidelines are based on invalid cost benefit analysis; that runoff is in fact a non point source and therefore should not be controlled under the Effluent Limitations Guidelines; and that the guidelines make no provision for waiving requirements even where it can be demonstrated that there is no appreciable harm. The suit is in the 4th Circuit U. S. Court of Appeals. A decision could be issued in the near future.

One area in which additional regulations may be anticipated is with respect to contamination of groundwater by leakage from ponds, such as bottom ash and flyash disposal ponds. At the present the control of ground water contamination is effectively the responsibility of the states. In general, state regulations, where they explicitly address potential effects on groundwater, fail to recognize that some leakage out of pond facilities is inevitable. A rational approach to regulation of this source of contamination would be to establish the amount and kind of degradation of the groundwater reservoir that would be acceptable. Such an approach would be consistent with present controls on discharge of water to surface water bodies, and also controls on discharges of contaminants to the atmosphere. The present federal Clean Drinking Water Act addresses groundwater contamination in terms of impact on existing wells used for public supply. However, it ignores aquifer contamination that might be encountered when future wells are drilled elsewhere in the aquifer.

An obvious effect of the federal and state water laws and regulations as well as all other environmental regulations has been to force upon the utilities an extended lead time for new facilities. This is required not only to provide for environmental baseline studies and analyses, but to allow for resolution of differences between the utility and the regulatory agencies. Time may also be required for resolution of contests brought by environmental groups against the utility during the licensing period.

It should be recognized by all parties that the utility industry has acted responsibly in arguing against delays and against increased costs of electric power generation, just as it should be recognized that environmental and regulatory groups have acted responsibly in arguing for mitigation of environmental degradation. As a result of these arguments, and of improving communications, the utility industry has shown an increasing awareness of environmental responsibility.

TOPIC II-D.

POWER PLANTS AND WATER RIGHTS

Summary Discussion

This session was arranged by the Environmental Effects Committee of the Power Division, American Society of Civil Engineers. It was intended to achieve a better balance of the various topics to be discussed at the conference. Thus, while there were 25 papers referring to fish and their needs, only the four of this session discussed the needs and the actual impacts of power plants on inland streams. The papers attempted to show that power plants, both hydro and thermal, have legitimate requirements for instream waters and that they can, to a large degree, be compatible with the many other uses presented at the conference.

Attendance at the session was fair. The brief discussion, as led by the moderator, centered around certain points brought out in the papers. Discussors appeared to be principally those who had a similar interest, from the utility side, in economically obtaining necessary diversion or utilization rights while at the same time minimizing environmental impacts.

Mr. Eicher's paper gave a number of illustrations of salmon spawning areas actually enhanced by construction of upstream dams.

Dr. Hamilton's paper cited a hydroelectric project on the Klamath River where minimum flows have been increased and substantially regulated and a hatchery built and operated with the project, all of which have been quite successful. The discussion concerned details of the operation.

Mr. Wise's paper asked that regulatory agencies cease their apparent policy of "ratcheting" requirements, so that each new power plant must meet flow and temperature conditions more stringent than the past. The discussion called attention to the nuclear reactor at Hanford which has operated on once-through cooling for several years with little impact on the fisheries resource, yet is about to be required by the State to install off-stream cooling towers.

Discussion of Dr. Titus' paper centered on the nuclear reactor, which should have demonstrated its suitability under Section 316a of the Water Pollution Control Act. It also brought out the possibility that zero discharge requirements could lead to contamination of groundwater supplies since adequate dilution would not be achieved.

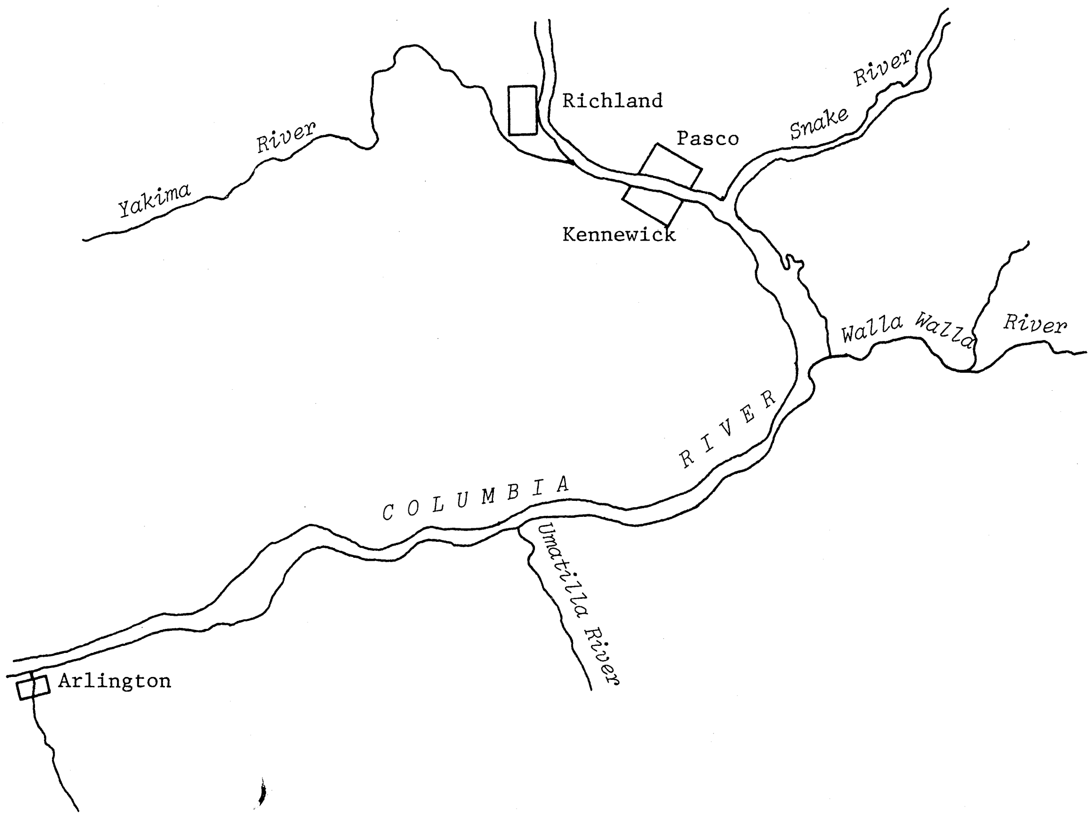
It is to hoped that the polarization that seems to exist between exponents of retaining the status quo and those of us who must meet by Nation's energy needs was mitigated even in some small measure by this session.

Notes by panel moderator: George Bingham, Bonneville Power Administration, Portland, OR

PROBLEMS OF THE PRIVATE IRRIGATION DEVELOPER

Raymond T. Michener, P.E.
Michener Associates, Inc.
Pasco, WA 99302

I am here as a representative of the commercial side of the instream flow needs. I am one of the "Fellows in Black Hats." I am a consulting engineer engaged in irrigation development. As you are aware, irrigation is by far the largest consumptive user of our waters.



My firm is licensed in six states but we do the great majority of our work in the 'Mid Columbia Basin' area of Oregon and Washington - this is our home. This reach of the Columbia River from above Richland, Washington, to below Arlington, Oregon; 100 miles along a great river running through high quality farm lands blessed with an excellent growing season.

Estimates of the irrigable land yet to be developed vary from 300,000 to 1,000,000 acres. Probably 500,000 acres is realistic. If we include the 500,000 acres plus, planned for the Columbia Basin Project it is over one million acres.

If we divert 4 acre feet per acre about 1 acre foot will return through surface or subsurface flow. A net of 3 million acre feet will be required. This is about 2.5% of the Columbia discharge at McNary Dam projected for 2020.

A peak flow of about 8,000 cfs will be required. This is assuming that 1/2 of the total acres will have their peak requirements at one time. This flow is 5% of the flow at McNary Dam. Even if the entire million acres peaked at one time the flow would be only 10% of the river flow.

My point is that, although the diversion requirements are high, percentage wise they are low. Power production feels the impact of these diversions directly. The other instream users can adapt to and live with the diversions. Power can be produced by other means.

My firm and I have practically grown up with the recent surge of private development along the Columbia. In 1966-67 our problems were in about this order:

Design
Financing
Permits, R.O.W.'s, etc.

Now the emphasis has shifted and the order is:

Permits, R.O.W.'s, etc.
Financing
Design

i.e. Design has taken a back seat to a horrible deluge of red tape. Rightly or wrongly the permits, etc. and the time required to secure them have become our no. one problem.

PLATE 2

GOVERNMENTAL AGENCIES INVOLVED IN PUMPING PLANT PERMITS

FEDERAL:

Department of the Army Corps of Engineers
  Washington D.C.
  District - Walla Walla - Portland - Seattle

Department of the Interior
  Fish & Wildlife Service - Portland - Seattle

Department of Commerce
  National Marine Fisheries

U.S. Environmental Protection Agency

U.S. Coast Guard

Bonneville Power Administration

STATE: - Washington

Department of Ecology
Department of Fisheries
Department of Game
Department of Natural Resources
State Parks and Recreation Committee
Department of Social & Health Sciences
Department of Highways

STATE: - Oregon

Oregon State Water Resources Board
Oregon State Division of Lands
Oregon State Department of Environmental Quality
Oregon State Department of Fish and Game
Oregon State Department of Highways

COUNTY:

Engineer - Roads
Shorelines (Washington)
Air Pollution Control

MISCELLANEOUS:

Private
Railroads
Gaslines
Telephone

I refer you now to Plate 2. Here I have made a partial list of the agencies, departments, and divisions that look into any private development.

Here is how the system is supposed to work. A private developer buys a piece of undeveloped land, nowadays at a very high price. He then secures a water permit to appropriate water from the river. Concurrently he presents his designs to the Permit Branch of the Corps of Engineers.

The Corps prepares and distributes a Notice of Public Works, NPW. This NPW is circulated to all of the concerned agencies, organizations, newspapers, and lord knows who-all. It contains a description and plans of the project. It asks that comments be returned within 30 days.

But the 30 day deadline is not observed closely if at all. Any one of the agencies listed on Plate 2 can stall the permit by putting a 'hold' on it or by simply not responding.

The Corps feels that they must have a response from all the agencies before they can proceed with the permit. So now begins a tedious and time consuming process of contacting these agencies to get their responses. Quite often the response is that they need more time to study it. Quite often a design change is required.

These days are very costly for the developer. He is generally working against a tight time schedule in order to get his system in in time for a crop. His interest charges on a costly investment run on and on.

He cannot conclude his financing arrangements so cannot order equipment on time for necessary delivery schedules.

I am often reminded of the bureaucratic response during World War No. 2 to the pleas of a sheep rancher for canvas to protect his sheep during lambing. He was told to just delay the lambing for a few weeks when the weather would be better.

The developer is not entirely without blame. He often, through ignorance or disregard, submits plans that do not consider the fisheries adequately.

He quite often earns his Black Hat.

He is careless and wasteful of water and power in his plans and designs.

He applies water to lands that are unsuited to agriculture.

He changes his plans, without authorization, during construction.

PLATE 3

WHAT CAN WE DO ABOUT ALL OF THIS?

On your side of the issue you can:

1. Provide us with a 'one stop' permit agency.
   In our case this would be the Corps of Engineers.
2. Lengthen the time of response to an NPW from 30 days to 45 days.
3. Shut off responses at that date. Do not allow any 'holds'.
   Do not require responses. Assume that an agency that does not respond is satisfied.
4. Exert authority to override objections or to negotiate changes in the plan.

On our side of the issue we should:

1. Design our work to protect the fish runs.
   Keep in contact with and work with the fisheries agencies to improve screens and channels.
2. Design our systems to be as efficient as practical in regard to power use and water withdrawals.
   a. Reservoirs where possible.
   b. Larger pipes (less friction).
3. Classify our lands. Do not supply <u>peak</u> water to Class IV lands.
4. Have jobs installed under the <u>responsible charge</u> of a licensed engineer. Have him certify that the job is constructed as planned.

CITIZEN INVOLVEMENT IN EPA'S WATER QUALITY MANAGEMENT PROGRAMS

Eldon H. Edmundson, Jr.
U.S. Environmental Protection Agency
Idaho Operation Office
Boise, ID 83702

ABSTRACT

The 1972 Federal Water Pollution Control Act contains specific requirements designed to encourage and assist public participation in the administration of any plan, standard, effluent limitations, regulations, or program established under the Act. This paper discusses the opportunities for citizen involvement in EPA water programs for planning, discharge permits, and construction grants as they relate to instream flows. Since the impact of a pollutant on any receiving stream depends on the amount of water present, instream flows must be considered in all water quality-related programs. The main portion of EPA planning activities are through the State River Basin Planning and State and local Areawide Wastewater Management Planning activities. Both activities specify that public hearings must be held on the proposed plan. In Areawide planning activities, the local or State entity must also form a citizens advisory committee to provide guidance in development of the plan. The discharge permit and construction grant programs specifically allow for public inputs. Citizens can review draft discharge permits before they are issued, and have 15 days after issuance to protest the final limitations. In the construction grant program, the city must hold public hearings to present to the citizens the selected sewage treatment alternative and environmental impacts associated with the proposed project.

INTRODUCTION

The authority for EPA Water Quality Management Programs is contained in the 1972 Federal Water Pollution Control Act (Public Law 92-500). The objective of this Act is to restore and maintain the chemical, physical and biological integrity of the nation's waters. The steps in attaining this objective include the identification of water uses the public wishes protected, the development of specific water quality criteria which ensure those uses are protected, and the instigation of an enforcement program. These components make up the State Water Quality Standards which become the framework for water quality programs. The EPA, State, and local activities for ensuring compliance with the Standards are contained in the planning, discharge permit, and construction grants programs. In the planning process, the public identifies those water uses they want protected. With this mandate, the agencies evaluate stream characteristics, including instream flows, and identify pollution control needs.

Citizen involvement is an integral part of our pollution control program. In fact, the Federal Water Pollution Control Act contains specific requirements for citizen involvement. This law directs implementing agencies to provide for, encourage, and assist public participation in the administration of any plan, standard, effluent limitation, regulations, or program established under the Act. EPA welcomes this directive and believes the success of our nation's efforts to clean up its waters depends on public participation by concerned citizens.

Until now, the special interest groups have probably made their views better known than the general public which is broadly affected by Federal, State, and local activities. Hopefully, the desires of the general public are reflected in the basic legislation, which leaves little room for administrative deviation by EPA or other implementing agencies.

In this paper, I would like to discuss the opportunities for citizen involvement in EPA water programs for planning, discharge permits, and construction grants and to discuss the relationship of these programs to instream flows.

Water Planning Programs

Planning is an essential part of any effort to attain water quality objectives. Several distinct planning processes have been established under the Act; each has its own scope and purpose and depends upon the others for its ultimate effectiveness. The major activities are River Basin Planning under Section 303e, Areawide Wastewater Treatment Management Planning under Section 208, and Facilities Planning, a basic planning element for municipal wastewater treatment under Section 201.

The River Basin Plan is primarily a State effort. This planning process sets up procedures to manage the overall water quality of a river basin, the area drained by a river and its tributaries. The Basin Plan identifies the pollutants found in waters within the basin and, after considering instream flows and water quality standards, sets limits through discharge permits on what can be discharged into those waters from point sources and identifies necessary programs to control nonpoint sources.

Citizen input normally occurs during the public hearing and review process on the draft plans. During the spring of 1974, the State of Idaho held public workshops to discuss River Basin Planning and to solicit from the public comments on water pollution problems and potential solutions. From the input received at these workshops, the IDHW developed draft River Basin Plans for the entire State. Public hearings on these plans are scheduled for June 1976.

The Areawide Waste Treatment Management Plan (Section 208) deals with water pollution problems that are local in nature. Specifically, it calls upon local governments in a particular planning area in cooperation with the State to identify and implement solutions to their local water problems. In areas where local governments are not conducting the planning activities, the State must carry out the necessary activities. The success of the 208 activity depends on local citizen involvement. This is one of the first legislative requirements which allows local people to identify problems and implement solutions to correct these problems. However, there are some requirements that the 208 agencies must meet. For example, the 208 planning process must assess the adequacy of water quality standards for the area and recommend any changes in the Standards which they feel are necessary to protect the desired water uses. The local agencies must then develop and implement programs for ensuring the instream water quality standards are met. One such program could be the setting of more stringent effluent limitations on discharges to surface waters from new and existing sources. Another program could be the identification of new or upgraded public wastewater treatment systems needed to ensure compliance with the water quality standards. One major consideration in setting these effluent limitations or identification of needed treatment systems is instream flows. The lower the flow of a stream, the lower the amount of pollutants which can safely be assimilated by the stream.

Citizens are an integral part in the formation of the Areawide Waste Treatment Management Plan. In fact, EPA regulations specify that 208 agencies must form a citizens advisory committee to provide input, and review the plan as it is developed. It is crucial that citizens become involved in identifying water uses to be protected, because this identification dictates what type of restrictions would be placed on a potential discharge. The three present Idaho 208 agencies, with offices in Boise, Pocatello, and Coeur d'Alene, have (or are beginning to form) their citizens advisory committees. Interested citizens should contact these offices to find out how they can become involved.

Permits

PL 92-500 specifies that all discharges to surface waters must have a National Pollutant Discharge Elimination System (NPDES) permit. The purpose of this program is to limit the amount of pollutants which can be discharged to a stream so that the goals of the Act can be achieved. The Act requires that these permits contain effluent limitations, monitoring requirements, and schedules to ensure dischargers achieve best practicable technology by July 1, 1977. Many discharges will need the equivalent of secondary treatment to ensure compliance with the Standards. However, because of low stream flows, other discharges will need a higher level of treatment. An example of such a discharge might be a municipality which discharges to a small stream which dries up during the summer or a large municipality discharging to a stream which has very low flows during the summer.

Citizen input is invited on development and revision of NPDES permits, and on monitoring of the performance of permit holders. Formal citizen review of a proposed NPDES permit occurs after the permit is drafted and before the final permit becomes effective. As an example, after EPA or the State has drafted a permit, it must be circulated for a 30-day review by public agencies, citizens, and interested organizations. After this period, EPA then evaluates all comments and determines what limits must be written into the permit to meet the conditions of the Act.

During the draft review process, EPA holds public hearings if we feel the permit is significant enough to warrent a formal public review or if we receive a significant number of requests for a hearing. After the public review process, EPA evaluates all the material submitted and either makes the necessary modifications and issues a permit or denies the permit. For 10 days after issuance, anyone can contest the permit. The Regional Administrator of the office issuing the permit evaluates any objections to the permit and determines appropriate action.

The most appropriate place for citizen input is during the public review of the draft permit. After the permit has been issued, citizens may become involved in seeing that the terms and conditions of the permit are carried out. Citizens can also focus pressure on permit violators by requesting copies of EPA's quarterly reports listing permit violations. These quarterly reports are required by law to identify permittees who are in violation of their discharge permit. Copies of these reports are available in each Regional EPA office.

Construction Grant Program

The next sequence in EPA's Water Quality Management Program involves construction of community owned sewage treatment systems. The first step in this process of constructing a sewage treatment system, and the point at which citizens need to become involved, is during the development of the Facility Plan.

The Facility Plan (Section 201 of the Act) reflects the detailed planning that goes into the building of waste treatment facilities. It considers a multitude of technical and environmental data and serves as the basis for a community's application for a federal grant to cover the costs of building or modifying its treatment facilities. To make certain that the public receives maximum benefit from a given expenditure, facilities planning procedures call for a detailed comparison of all possible courses of action. When evaluating alternatives, one must consider how the effluent from the sewage treatment plant will be disposed. For example, will it be discharged to a nearby river or stream? Will it be used for irrigating crops during the summer and stored in the winter, or will it be stored year around? In most cases, the cheapest alternative may be to provide secondary treatment and discharge to a nearby stream. However, in many cases the stream flow is not large enough to handle the effluent without resulting in a water quality standard violation. In these situations, municipalities would need to provide a higher level of treatment or refrain from discharging to the stream. The citizens of the community must become involved in making these decisions.

EPA requires a minimum of one public hearing during the development of the Facility Plan to discuss the proposed alternative and potential environmental impacts. We also encourage communities to hold as many informal meetings as necessary to keep the citizens informed and allow them an opportunity to actively participate.

Conclusions

Instream flows are a factor in water quality programs involving planning, discharge permits, and construction of sewage treatment systems. Through the planning process, agencies identify effluent limitations necessary to ensure compliance with water quality standards. Dischargers are then issued permits, effective for not more than five years, which limit the amount of pollutants discharged. The next step is the construction of private and public wastewater treatment systems. When setting effluent limitations, instream flows are taken into account. However, we have no guarantee that five years from now stream flows will be adequate. If stream flows have diminished, additional treatment may be necessary.

Citizen involvement in these water quality programs should be guided by one overriding principle: The earlier people get involved, the better. If opinions and ideas from citizens are received during the initial planning stage, the completed project will reflect the community's preferences and goals. In addition to contributing to the planning process, concerned individuals and groups can conduct their own environmental evaluation, limited only by their resources and imagination.

PUBLIC INVOLVEMENT AND WATER RESOURCE PLANS

Doli Obee
League of Women Voters of Idaho
Boise, Idaho

That you have asked me to be a part of the program for this conference and that I have accepted your invitation is proof that we agree on the importance of my topic - public involvement in resource plans. And you chose me, I think, because I represent an organization whose very existence is based on a firm belief in the need for informed citizen participation in decision making, something the League of Women Voters has been promoting with success for more than fifty years.

Public involvement in policy decisions is nothing new, of course, although I'm sure we'll all agree about the tremendous increase which has taken place in the last decade. Not only is there greater citizen interest in influencing policy decisions, but also more awareness on the part of legislators and public agencies that to have the citizen's point of view represented is not only desirable - it is necessary. Part of the reason for this stems from the increasing and conflicting demands which are competing for our resources, Right now I am very aware that last night the first public hearing took place concerning the Draft Summary Report for the Snake River Basin section of Idaho's State Water Plan. The most crucial fact connected with this report is that there are more demands for the use of the Basin's water than there is water in the Basin. As our demands continue to outstrip our available resources, and our problems grow more technically complex, I think we will need each other more - you, the experts, and we, the concerned citizens. I shan't speculate on whether or not it is proper that we continue to make very technical decisions in the political arena. I am most anxious that we band together to make them as good decisions as possible.

The most important reason for citizens to become involved in resource planning decisions is to provide advocates for the public interest. All of the vested interests will be eloquently represented. And even when we speak of the interested citizen, his response needs to be evaluated. Does he speak for the public interest, or have private property rights and economic considerations blinded his view of what is in the public good? Lakeshore homeowners should have an interest in the water level, and yet the historic high water mark as a property line or shoreline buildings restrictions seem to claim all of their attention.

Citizen involvement manifests itself in many ways: response through such regular channels as letters to public officials, statements at hearings, petitions, the initiative or referendum, and service on advisory boards. The League of Women Voters believes in the effectiveness of workshops as vehicles for informing and motivating people to act on issues. There are also any number of good attention getting gimmicks which have been used by citizen groups. And while the organized group is necessary, there is no doubt at all that the most effective form of citizen response comes when an individual speaks out for what to him seems right. People like myself, who hold offices in citizen organizations, I think should be called professional citizens. And we are effective only insofar as we succeed in promoting informed individual response. The organized group must continue to speak out, but along with the clear realization that it's reason for existence is chiefly to coordinate and disseminate information on problems and the ways to influence right decisions concerning them. Because I am concerned that the individual citizen is not becoming sufficiently involved in water resource problems I's like to talk about ways in which we might improve the situation.

Of first importance is communication, at all levels and in all directions. I note with approval that last night's speaker addressed himself to the problems of communication. I hope he included the need for this between the professional and the citizen. It seems that in this, the age of communication, the more we go through the motions the less we seem to understand each other. Those signs you see on office walls about what you think I said and what I think you think I said are too true to be funny. Part of the problem lies in the always increasing mass and technicality of what we communicate, and part, I think, in the fact that we are so constantly bombarded by communications of all sorts that we have learned to ignore a great part of what we hear and even of what we read.

More and more, also, we tend to speak the particular jargon of our professions - even the League of Women Voters has a lingo all it's own. Like a federal agency we are guilty of changing the recipe on our alphabet soup from time to time. But as groups become more specialized, simple English is becoming a forgotten language. Not only does the speech take on a foreign sound, the basic thought processes tend to take on specialized and circumscribed forms. Philip Slater, the sociologist, suggests that "cold,dry,hard" facts need to be mixed with some warm, soft wets ones from time to time in order to produce living wholes. I do not think the groups represented here today are as guilty of this as are others such as nuclear engineers. I understnad, for instance, that someone who gets hit with a heavy dose of radioactivity is not called a a "victim" but a "receptor" and that leakages of radioactive material are known as "migrations". Understanding the terms, is it any less upsetting to hear that somebody became a receptor due to a migration? But let me say quickly that some of the most effective and articulate environmentalists I know are engineers.

Even in the area under consideration today I've found that it takes a bit of explanation to give a layman a clear idea of all that is meant by an instream flow. And to say of a river reach of attractive looking water that it is sterile immediately brings the question, "Whatever do you mean?". In common parlance, of course, sterile refers to uncontaminated laboratory purity rather than lacking in the variety of aquatic life necessary for a balanced ecosystem. And don't forget how the vested interests, who oppose a given stand or piece of legislation, will take advantage of such misunderstandings. Haven't you heard it said of the 1972 Water Pollution Control Act Amendments that it's a foolish goal to expect our streams to reach distilled water purity by 1985? Wilful as this misunderstanding is, it certainly serves to add to the confusion about an already complex law.

An important part of good communication is a clear understanding of the consequences of a given action. I grew up in Colorado and I watch with great saddness what the pressures of more and more people and development are doing to that very beautiful part of our country. A film I saw on Colorado's water resource problems had the necessary kind of impact. It suggested that, at the present rate of growth, ultimately the only free flowing water in the state would be that in the protective hands of the federal government in such places as Rocky Mountain National Park. The film kept alternating shots of dry mountain stream beds with those of sprinklers on green, green lawns and of waste water running down gutters. I heard comments that the film was guilty of overkill. Yet as I think of the mountain streams I know and love in Colorado, I am haunted and I wonder. If more people were convinced that it really could happen, surely the likelihood that it will would be diminished.

It is also important that an issue be made interesting. I often remember what is surely the classic book report. Of the required selection one high school student simply wrote, "This was an interesting book if you were interested - only I wasn't". I haven't any concrete suggestions on how to make a subject interesting except to hope that if people have compelling factual information presented along with a clear sense of the probable consequences they will be interested. If they aren't they simply won't pay any attention.

Now a final warning about communication between the professional and the citizen. In spite of what I've said, don't underestimate the citizen. Do make what you write or say clear, relevant and interesting, but do include facts rather than limiting yourself to pleasant generalities. Although citizens don't need to become experts, how can they know what they believe or express themselves adequately without a solid basis of fact? How can they recognize the difference between fact and distorted fact? One of New Mexico's most effective environmental spokesmen is an engineer who became committed to the task of trying to keep industry honest after he had been to a public hearing. A recent federal agency publication, which is handsome to look at and deals with a timely problem, undoubtedly ended up in a number of wastebaskets because it doesn't contain any real information. As two different surveys done for the Idaho Water Resource Board on citizen attitudes concerning water resource problems showed, in a year's time the general level of understanding about water problems in Idaho had improved. I think you would find this true in all resource fields today.

Cooperation is another very important ingredient for getting effective citizen involvement on public issues. Citizen groups tend for the most part to be specialized, many of them having been formed to speak to a specific problem. Just as the admonition about everything being connected to everything else holds true in the physical world, however, so does it apply in the social system. An example would be the Citizens for Alternatives to Pioneer, a group formed to protest the Idaho Power Company fossil-fueled power plant proposed for a site 30 miles south of Boise. Every single member of this group should study the Water Plan and come to the hearings to speak out and particularly on three Recommendations; one, two and seven. The first recommendation speaks to the amount of new land to be developed for agriculture. Number two would give the Director of the Department of Water Resources the authority to consider the public interest as expressed in the water plan when approving or denying a water right application. Number seven would establish minimum stream flows for the waters of Idaho. The last two would help provide the capability for existing hydro facilities to operate at their maximum potential. Most of the opposition to Pioneer has been based on economic considerations as irrigators are asked if they can afford to pay for power at two and a half times the present rate. The final version of the water plan will have a lot to do with the answers of all of these questions. Of course, every member of a Fish and Game League in the state should come out and speak to the plan. Under the first recommendation the preferred acreage increase for agriculture would not provide water for instream flows throughout the state. Inherant, also, in such an increase in agriculture is loss of habitat as well as water. I hope I am pessimistic in my estimate of how many individuals will come out to speak for a good water plan. The irrigators will be out in numbers to speak against it.

Of all of the things necessary for effective citizen involvement the most difficult and elusive to maintain is committment. Perhaps we don't spend enough time considering those things which impede the citizen's desire to get involved. For the professional citizen, who is on every mailing list, some of the reasons are obvious. We are inundated with requests for response, and on more and more technical topics. Last week, for instance, I received the draft environmental statement on phosphate development in eastern Idaho - all eight pounds of it. I will have to put in hours of study before I will feel comfortable about responding in the name of the League on the impacts on the water resource.

Not long ago a local League president showed me with wry amusement a letter she'd received from a federal agency district manager after she'd failed to attend a meeting to which he'd invited her. In essence he said, "We've been told we need public input on decisions and we intend to comply, but how can we if you won't come and put in?" What he didn't know was that his meeting would have been the fifth that week for her in the role of the interested citizen. I've heard legislators say of the League observer corps, which puts in long hours during the legislative session keeping track of those issues which concern us, that those women are at the Statehouse because they have the time. In fact, they are there because they believe it is important to take the time. All groups are finding it increasingly difficult, moreover, to find people who are able to take the time. More and more people are taking regular jobs, preferring to receive pay for what they do, and often utilizing experience gained while working as a volunteer with a citizen's group. The many people with regular jobs who believe in the need for participating in decision making must do so on their own time. We all know busy, busy people who constantly spend the time they would like to use enjoying a quality environment in efforts to keep it that way. The industry lobbyist, when confronted with an impact statement, can not only give it his on-the-job time, but can often utilize staff members to do research for him. I wish there were some way agency personnel could take this inequity into account when planning the dates for hearings and written response times. I know that these are sometimes mandated by law, in which case the drafters of the legislation should keep in mind just who it is they want to respond. And I'm not even going to talk about the problems of funding in the volunteer group, nor obtaining office equipment and secretarial help.

When it comes to involving citizens effectively in resource decisions, timing also has a lot to do with it - timing and geographical proximity. It seems that more often than not it takes longer to resolve a resource problem than it is possible to maintain a high level of citizen interest. I am not talking about the dedicated few who never seem to give up in their efforts to improve man's relationship with his environment, but about that broad response which is necessary for the sort of mandate it is impossible to ignore. I am particularly aware of this when it comes to implementation of the various sections of PL 92-500. While there has never been a piece of legislation with more built in opportunities for the citizen to speak out, I am afraid that the whole problem of water quality is of less general interest than it was when the law was passed.

In closing, let me give a pertinent example. I do not think you could find a more thorough effort to involve citizens in the making of a water resource decision than that which was undertaken in the formulation of Idaho's Water Plan. The first effort went into finding out what Idahoans want. The staff of the Department of Water Resources has held in all over eighty public meetings throughout the state. Particularly at the outset, in most cases the attendance was large and the interchange was lively. Three public opinion surveys were conducted, the last in cooperation with the Idaho's Tomorrow program. A newspaper supplement in which all of the problems Idaho faces in making water resource decisions were set forth was published in every paper in the state. The supplement included a questionnaire, and over 2,500 of these were filled out and returned. The upshot of this truly commendable effort in opinion gathering convinced the staff that the citizens of this state appreciate what they have in the way of environmental quality and that they want to keep what they have. While there had been astrong feeling expressed for continuing agriculture as the state's main economic base, there was also a strong preference expressed for minimum stream flows and wild and scenic rivers. The staff then measured what they had heard against the resources of the state as they saw them through their research efforts. Last March the first portion, the Draft Summary of the Snake Basin Report, was published. It is a generally good plan. While there are areas where environmentalists have legitimate reasons to object, for the most part it is geared to meeting anticipated future growth with the least possible loss of environmental quality.

What should happen now is wide citizen support for the plan, along with constructive suggestions on how to make it better. What seems to be happening makes me very uneasy. Last week the Water Resources staff finished their final series of statewide meetings for the purpose of explaining the plan. These meetings have been of two kinds; packed, and with a lot of opposition from the agricultural community, or poorly attended, and with little or no response.

Unless things turn out quite differently than this would lead one to expect, after the hearings the Water Resource Board will come to the conclusion that the people of this state do not want the sort of environment the staff efforts had led them to believe was the case. I firmly believe the staff estimate of attitudes is correct, although I am at a loss about how to get all of the people who answered the questionnaires to come out and say once more how they feel.

The Water Plan is expected to provide a guide, or road map, for water resource decisions until the year 2020, with check points for review along the way. And this brings me back to where I started. Perhaps because I now have four very satisfactory grandchildren, I am more aware than I used to be of the importance of taking a long view of the public interest. As I go over the conflicts which are inherent in the Water Plan, or any other natural resource plan for that matter, I keep wondering what sort of world these particular little people will grow up to enjoy. Such decisions have to be made, not once, but again and again, and if we cherish the label of responsible citizen we will keep making them over as often as we must. T.H. Watkins at the end of his book on the public domain, The Lands No One Knows, puts it better than I can. If we don't do our jobs "we will have turned our backs on our responsibility to all those who follow us - our children, our children's children, their children, and all of the generations of children in the distance beyond our own mortality".

PARTICIPATION AND REPRESENTATION IN WATER RESOURCE POLITICS*

John C. Pierce
Department of Political Science
Washington State University
Pullman, WA 99163

ABSTRACT

The relationship between the public and water resource policy depends on two linkages: (1) between the public and water resource political activists; and, (2) between activists and the policy makers. This paper focuses on the first linkage and examines the extent to which six kinds of water resource policy participants "represent" the general public in background characteristics and water policy preferences. The results are based on the responses of 687 residents of Washington State. On the average, members of citizen advisory committees are the least representative of the public in terms of background characteristics, while organization members and citizen committee members are least representative in terms of policy preferences. Water policy activists over-represent waterfront property owners, people with high levels of water resource use, people dissatisfied with water resource policy, and people who rank recreation as a high priority use of water. Interpretations of the implications of the results depend on the extent to which policy makers uniformly respond to those who engage in different forms of participation as well as the particular view of representation one adopts.

INTRODUCTION

Substantial criticism has been directed at water resource management. Much of that criticism alleges an absence of public involvement and representation. Traditional political processes are claimed to systematically over-represent some interests and under-represent other interests. Formal mechanisms of public involvement have emerged as widely prescribed panacea for the unresponsive process.[1] Partially in response to demands for a more

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[1]See the discussions in the following: Arnold W. Bolle, "Public Participation and Environmental Quality," Natural Resources Journal, Vol. 11 (July, 1971); Thomas E. Borton, Katherine P. Warner, and William J. Wenrich, The Susquehanna Communication - Participation Study: Selected Approaches to Public Involvement in Water Resources Planning (Springfield, VA: Clearinghouse for Federal Scientific and Technical Information, December, 1970); Daniel A. Dreyfus, "Competing Values in Water Development," Journal of the Hydraulics Division, 9 (September, 1973); and, Norman Wengert, "Public Participation in Water Planning: A Critique of Theory, Doctrine and Practice," Water Resources Bulletin, Vol. 7, No. 1 (February, 1971).

open policy process, many public agencies have experimented with a variety of participatory mechanisms. Increasingly, agency guidelines suggest formalized public input in the decision-making process. But, in some cases experimental programs have proved unsatisfactory;[2] in others, little attention has been paid to the actual empirical representation relationship. That is, the participants and the public often are assumed to be synonymous.

Critics of the water policy process, on the other hand, often make an opposite assumption--that the traditional participants in water politics are not representative of the public, that they distort the relevant characteristics of the public. The participants are thought to be a biased sample of the public. The suggested cure includes widespread and open participation opportunities. Both defenders and critics of the present process make important assumptions about the purpose of participation and the representativeness of the participants. Yet, there is little empirical evidence comparing participants to the general public and thereby indicating which participants are most representative.

WATER POLITICS AND REPRESENTATION

The question of whether the water resource policy process is representative turns on several political linkages.[3] Initially, there is the linkage between the general public and the participants who interact with policy makers. However, the link between participants and policy makers is just as important. Participants may be fully representative of the public, but if policy makers are unresponsive, policy will not reflect the public's preferences.[4] At the same time, of course, policy makers may be perfectly

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[2]Daniel Mazmanian, "Participatory Democracy in a Federal Agency" in John C. Pierce and Harvey R. Doerksen, eds., Water Politics and Public Involvement (Ann Arbor: Ann Arbor Science, 1976).

[3]For a discussion of political linkage in general, see Norman Luttbeg, ed., Public Opinion and Public Policy, revised ed. (Homewood, IL: The Dorsey Press, 1974). Also, see: John C. Pierce and Harvey E. Doerksen, "Citizen Advisory Committees: The Impact of Recruitment on Representation and Responsiveness" in Pierce and Doerksen eds., Water Politics and Public Involvement.

[4]For discussions of the attitudes of policymakers see: Geoffrey Wandesford-Smith, "The Bureaucratic Response to Environmental Politics," Natural Resources Journal, Vol. 11 (July, 1971); and, Raymond L. Wilson, Toward a Philosophy of Planning: Attitudes of Federal Water Planners (Washington, D.C.: Environmental Protection Agency, 1973).

responsive to the participants, but the participants may not reflect the general public.

Any complete understanding of the role of the public in water resource politics necessarily is based upon information about both linkages: the linkage between the public and those who represent it; and, the linkage between the public's representatives and those who make public policy. In principle, however, one linkage is prior to the other--the linkage between the public and the participants. Thus, this paper is drawn to a consideration of the linkage between the public and its members who are active in water resource politics. The central questions are these: Do the participants in water resource politics represent the general public? Are some kinds of participants more representative of the public than other kinds?

The analysis of representation in any context is a difficult task at best. Representation is basic to many of the great political and philosophical arguments. Moreover, the concept of representation itself has many dimensions.[5] Thus, conclusions as to the level of representation can be based on alternative criteria. Among the alternatives are the representative's actions, policy preferences, personal characteristics, and mode of selection. The choice of which criteria to employ depends largely on the nature of the representatives one is evaluating. The concern here is with the concurrence between the distributions of characteristics and preferences of the general public and those of several participant publics.[6] The participants in water resource politics are compared to the public in terms of (a) their background characteristics, and (b) their water policy orientations. This addresses the questions of whether the participants, when compared to the general public, come from the same social/economic locations and prefer the same solutions to problems of water allocation.

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[5]Hanna F. Pitkin, The Concept of Representation (Berkeley: University of California Press, 1967).

[6]For discussions of the meaning and measurement of concurrence as it relates to representation, see: Susan Blackall Hansen, "Participation, Political Structure and Concurrence," The American Political Science Review, Vol. 19, No. 4 (December, 1975); Anne L. Schneider, "Measuring Political Responsiveness: A Comparison of Alternative Methods," in Pierce and Doerksen, Water Politics and Public Involvement; and, Sidney Verba and Norman Nie, Participation in America (New York: Harper and Row, 1972).

METHODS AND MEASURES

A mail questionnaire survey of Washington residents was conducted in the period from October, 1974 through January, 1975. A sample size of 687 resulted, with a response rate of approximately 65 percent of those contacted. Each respondent was asked to indicate whether he/she had attempted to influence water resource policy through each of six methods. Table 1 shows the percentage participating in each of the six kinds of attempts to influence water resource policy. The subsequent analysis assesses the degree to which each participant group is a representative sample of the general public.

Table 1
Public Participation in Six Activities for Influencing Water Resource Policy

	Activity					
	Attending Public Hearing	Contacting Government Agency	Contacting State Legislator	Joining Group	Citizen Advisory Committee	Signing Petition or Initiative
Percent Participating	18%	9%	10%	7%	3%	33%

The comparisons drawn in this study are based on the background and policy characteristics of respondents. The following background variables are employed: age, education, occupation, income, ownership of waterfront property, four uses of water, and an overall index of water resource use. The policy variables have two emphases. First, we compare the participants and general public in terms of satisfaction with water resource policy. Second, each respondent was asked to rank seven alternative priorities for the use of water in the order in which he/she preferred them. The alternatives which were ranked include agriculture, preservation, domestic, energy, industry, recreation, and transportation. The rankings are collapsed into three categories: most preferred (rankings one and two), middle (rankings three, four and five) and least preferred (rankings six and seven).

Representation is viewed here as the degree to which the distributions of characteristics of the participants match those of the whole public. A statistic enjoying increasing use as a measure of this concept of representation is the Gini Index of Inequality.[7] The Gini Index measures the extent to which the distributions of two groups on a variable are unequal. Its calculation also reveals the extent to which individuals with a given characteristic in one group are over-represented or under-represented in the second group. The Gini Index ranges from 0.0 to 1.0. Perfect equality of representation obtains when the index is at zero; complete inequality is present when the index is at 1.0.

FINDINGS

Just how much representation is present? The results are shown in Tables 2 and 3. Table 2 presents the Gini Index scores for the background characteristics, while Table 3 does the same for the policy oriented variables. In each table two sets of information are provided: the Gini Index when comparing each participant group to the general public; and, the specific characteristic over-represented by the participant group.

Several clear patterns emerge from the data on background characteristics. Most prominent among them is the level of inequality for those who join citizen advisory committees. CAC members over-represent the better-educated, white collar occupations, higher income groups, waterfront property owners, those who use water for transportation and business, and those who use water for multiple purposes. Thus, one of the most systematic, formal mechanisms for public involvement produces the participant group among the least representative of the public. Individuals who report joining a group to influence water decisions over-represent the middle aged, white collar occupations, people with high income, and water users; those who attend public hearings over-represent waterfront property owners (as do those who report contacting a legislator to influence water policy) and transportation users. On the average, those who sign petitions to influence water policy display the least inequality. The general public receives the most representation on the bases of the use of water for irrigation and the use of water for recreation. Representation is most unequal across the variables of waterfront property ownership and the overall water use index.

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[7]For the calculation of the Gini Index, see: Hayward R. Alker, Jr., Mathematics and Politics (Yale University Press, 1965); and, Schneider, op. cit. For a recent use of the Gini Index see Kenneth John Meier, "Representative Bureaucracy," The American Political Science Review, Vol. 69, No. 2 (June, 1975).

Table 2
Participant Type and Gini Index of Inequality on Background Variables[a]

TYPE OF PARTICIPATION ACTIVITY

Background Characteristic	Attend Hearing	Contact Agency	Contact Legislator	Join Group	Join CAC	Sign Petition	Mean Index
Age	.13	.16	.08	.17	.08	.11	.12
Education	.08	.07	.12	.08	.24	.10	.12
Occupation	.05	.13	.11	.22	.20	.04	.13
Income	.07	.14	.06	.17	.31	.05	.13
Property Ownership	.20	.15	.21	.11	.20	.10	.16
Water Use:							
Irrigation	.06	.04	.01	.15	.06	.01	.06
Recreation	.01	.01	.06	.09	.12	.06	.06
Transportation	.15	.04	.11	.05	.28	.02	.11
Business	.13	.09	.11	.01	.45	.06	.14
Water Use Index	.13	.12	.12	.20	.49	.13	.20
Mean Index	.10	.10	.10	.13	.24	.07	

DIRECTION OF INEQUALITY

Background Characteristic	Attend Hearing	Contact Agency	Contact Legislator	Join Group	Join CAC	Sign Petition
Age		middle-aged		middle-aged		
Education					high education	
Occupation				white collar	white collar	
Income					HIGH INCOME	
Property Ownership	owners	owners	owners		owners	
Water Use:						
Irrigation				irrigation users		
Recreation						
Transportation	transportation users				TRANSPORT. USERS	
Business					BUSINESS USERS	
Water Use Index				moderate and heavy use	HEAVY WATER USE	

[a]The entry in each cell of the upper table is the Gini index for that participant group and the general public on the variable on the left side of the table. In the lower table, the entries report which group in the population is over-represented. If the name is in all lower case, the Gini index score is .15-.19; in lower case and underlined, the score is .20-.24; and, if in upper case the score is greater than .25.

Table 3
Type of Participation and Inequality of Representation on Policy Variables[a]

TYPE OF PARTICIPATION ACTIVITY

Policy Variable	Attend Hearing	Contact Agency	Contact Legislator	Join Group	Join CAC	Sign Petition	Mean Index
Water Policy Satisfaction	.14	.29	.24	.17	.60	.09	.26
Policy Ranking:							
Agriculture	.02	.02	.08	.31	.07	.07	.10
Preservation	.05	.03	.03	.18	.18	.08	.09
Domestic	.02	.16	.08	.06	.04	.02	.06
Energy	.10	.08	.05	.13	.29	.04	.12
Industry	.05	.04	.02	.24	.03	.09	.08
Recreation	.10	.20	.20	.22	.13	.14	.17
Transportation	.09	.06	.07	.10	.07	.06	.08
Mean Index	.07	.11	.10	.18	.18	.07	

DIRECTION OF INEQUALITY

Background Characteristic	Attend Hearing	Contact Agency	Contact Legislator	Join Group	Join CAC	Sign Petition
Water Policy Satisfaction		DISSATISFIED	Dissatisfied	Dissatisfied	DISSATISIFED	
Policy Rankings:						
Agriculture				LOW RANKING		
Preservation				High Ranking	High Ranking	
Domestic		Low Ranking				
Energy					MIDDLE & LOW RANKING	
Industry				<u>High Ranking</u>		
Recreation		<u>High Ranking</u>	<u>High Ranking</u>	<u>High Ranking</u>		
Transportation						

[a]The entry in each cell of the upper table is the Gini index for that participant group and the general public on the variable on the left side of the table. In the lower table, the entries report which group in the population is over-represented. If the name is in all lower case, the Gini index score is .15-.19; in lower case and underlined, the score is .20-.24; and, if in upper case the score is greater than .25.

A second and perhaps a more crucial question is how well the various participant groups represent the public across policy preferences. A comparison of participant groups and the public across policy variables yields patterns similar to those noted above. Again, inequality of representation varies substantially across participant groups as well as across policy variables. The greatest inequality appears in the water policy satisfaction levels; in each case, participants are less satisfied with water policy than the general public, with CAC members displaying extreme over-representation of dissatisfaction. Across policy priority rankings we find only minimal inequality of representation. Policy participants tend to over-represent those in the public who give high rankings to recreation. CAC members and group members are the least representative (on the average) of the public. Members of CAC's seriously over-represent dissatisfaction with water policy, middle and low rankings for energy, and mildly over-represent high priority rankings for preservation. Group members over-represent the dissatisfied public, high rankings for preservation, industry and recreation, and low rankings for agriculture. Those who contact legislators and agency personnel mildly over-represent the dissatisfied and those who give recreation high rankings. Those who contact agency personnel over-represent those who are dissatisfied, give domestic uses low ranks, and recreation high ranks.

IMPLICATIONS

Critics of the water resource policy process are at least partially correct. In some cases, those who participate most actively in water resource politics are unlike those who do not participate. In fact, those forms of participation which include the very small, more activist portion of the public (groups and CACs) are the least representative. Interestingly, citizen advisory committees are the outgrowth of a formal mechanism designed to correct the alleged abuses of a group dominated policy arena. Citizen advisory committees may shift the locus and visibility of public involvement, but they do not appear to stand as substantial correctives to inequality of representation.

In a sense, the most important findings of this analysis are the additional questions it raises. We previously noted that the linkage between the public and those who participate in water politics is only the first stage of the policy process. Although it is prior to the actual policy making, there are no guarantees that it plays a significant role in the decisions of policy makers. If policy makers do not base policy on the opinions represented by active participants, then the observed responsiveness is of little substantive import for representation.[8] Moreover, we do not know with certainty the weights assigned by water policy makers to the alternative participant activities; that is, we do not know to which participants, if any, they accord credence and attention. Thus, conclusions about the overall linkage process must be purely speculative until more data on the remainder of the process are available.

Secondly, we have no information about the internal decision-making procedures and strategies of the participant groups. This is particularly relevant to members of water resource organizations and citizen advisory committee members, since collective action need not necessarily represent an aggregation of group opinion. Within interest groups and citizen advisory committees, certain members are more influential than others in determining group positions or affecting policy makers.

Despite the limitations, the data presented here should at least lead policy makers to ask several important questions, both empirical and normative. The first question, of course, is which participant groups are most representative of the public. That question is at least partially answered here. A second, more normative consideration, pertains to the goals of the water policy process: Who <u>should be</u> represented in that process? Should it be those who show an interest and have a stake in the policy process or should it be the general public, however that is defined? If one feels that the opinions of those who are more directly affected by water policy ought to receive more weight in the decision-making process, these data can help policy makers identify those activists. On the other hand, one may be committed to the principle that the process should produce participants with relevant characteristics in equal proportion to their incidence in the public. If so, the implication is that public involvement programs should be designed to provide a reason for participation for those who presently are not active. It is clear that those who presently are involved have such reasons. That is, the activists are more likely to own waterfront property, to use water resources, and

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[8]While the participation may have little impact on representation in such a case, it still may perform other desired functions, either for the participants or for policy makers.

to be dissatisfied with current water resource policy. The basis of those characteristics as incentives to participation is clear enough. The kinds of incentives required to induce participation from those without such direct interests in water policy are not quite so evident. If nothing else, public involvement programs should experiment in the kinds of incentives that are offered to participants to see if variations in structure and process alter the representative nature of the participants.

At the same time, one may believe that the basis for judging the acceptability of the policy process is not the policy positions of those who are involved, but rather the process by which they are involved. The question here is whether the participation process is sufficiently open. These data do not directly answer that question, even though they support the need for the answer. Bias in the representative nature of participants may be a consequence of some bias in the process. To answer that question, there needs to be further study of those who do not participate to determine if the non-participation is a result of the absence of motivation or the absence of opportunity. If the latter is the case, then public involvement programs should themselves be more concerned with process rather than substantive representation. The focus of research into public involvement programs should then be: What do potential participants view as realistic or viable participation opportunities, given the attitudinal and behavioral constraints under which they must live?

Finally, it is important to reiterate a point forwarded earlier. Representation is a multi-stage process. Participation is one linkage mechanism. The linkage is between the public and those who make public policy. At the minimum, in the context of this paper, for representation to occur it must be present in the linkage between the public and the participants, and then between the participants and those who make the policy. This research has focused only on the first stage in the linkage. In the long run, answers to the problems raised here may be only partial solutions. Perfect representation between the public and participants, either in terms of the kinds of people or in terms of the openness of the process, may mean little if public officials are unresponsive. At the same time, failure in the first stage of the linkage can be overcome. Indeed, policy makers may represent the public even when activist participants do not. This too, however, is an empirical question and one to which further research should be directed.

TOPIC II-E.

PUBLIC INVOLVEMENT IN WATER RESOURCE PLANS

Summary Discussion

Mr. Michener had listed a number of things that could be included in the design of pumped irrigation developments to conserve water and energy. The question was raised concerning who should make sure that these things are done. He responded that developers and licensed engineers should implement the recommendations. Another question asked specifically if the Washington State Department of Ecology should deny permits to appropriate water if, for example, a developer planned to irrigate class four land in violation of one of Michener's recommendations. Michener answered by indicating that such state action was unnecessary because the cost of energy was making it uneconomical to use pumped irrigation on anything but highly productive land.

Regarding Michener's criticism of the delays entailed in getting approval of numerous agencies before beginning a project, a member of the audience asked if Washington state's clearinghouse process for one-stop approval was helpful. Michener said the procedure was a step in the right direction, but he emphasized that the clearinghouse agency failed to adhere strictly to deadlines regarding submission of responses by other agencies. In addition, he complained that when objections were raised, the developer was frequently required to work out any problems with the specific agency raising the objection.

Mr. Edmundson was asked how effective citizen involvement efforts by the EPA were. He indicated that for the 208 programs participation was high, and he suggested that this was particularly important because they were planning programs. With regard to responses to applications for discharge permits, public participation was very low, he said. However, since most of the basic standards for granting or rejecting permits were well established, Edmundson suggested that public participation was less important than in some other matters.

Mrs. Obee was asked what she meant by "the public interest" regarding the plan being considered for management of the Snake River system in Idaho. She said that the plan itself was an effort to define what constituted the public interest, although she did not agree with all aspects of the present draft of the document. In response to an assertion that the plan would give one official power to control all water in the state, Mrs. Obee claimed that the plan contailed strong guarantees that vested rights would not be abridged.

It was asked if low participation on citizen advisory committees might be a function of failures to ask more people to serve. Pierce responded that such efforts might well increase participation, but he said that this would not solve the problem of who should be asked to serve. In response to an inquiry regarding why discontented individuals participated more, Pierce suggested that it was rational for a person to forego participating if existing or suggested policies were acceptable to them.

Notes by panel moderator: Race D. Davies
Steering Committee Member

COMPREHENSIVE LAND USE PLANNING AND INSTREAM FLOW NEEDS: THE POTENTIAL IN OREGON'S APPROACH

Neal L. Coenen

Department of Land Conservation and Development
1175 Court Street N.E.
Salem, Oregon 97310

ABSTRACT

This presentation first describes two key aspects of Oregon's developing land use program which is based on the Oregon Land Use Planning Act of 1973. The functions and purpose of Goals and Guidelines and Coordinated Comprehensive Plans is briefly reviewed. The need for coordination and comprehensive coverage of planning efforts are investigated in detail as are the various characteristics of conflict inherent to planning. In the second section of the presentation instream flow needs and related conflicts are discussed within the context of a site specific to Oregon's coastal zone. Then the steps of the planning process mandated by the Oregon Land Use Program are outlined and two Goals are reviewed for their specific relevance to instream flow needs. Finally, a brief example of intergovernmental coordination in developing comprehensive plans, using the Goals referenced, is provided to indicate how the planning process should work.

INTRODUCTION

After reviewing the diverse character of concerns identified in the program brochure, which will be addressed by other participants of the symposium, I thought I could best contribute to this session's discussion by describing:

1) the two key components of Oregon's developing land use planning program insofar as they are based on the need for greater comprehensiveness and coordination of planning; and
2) the potential of Oregon's program for addressing and incorporating the concerns relating to instream flow needs by using a few examples of how the process will work.

OREGON'S LAND USE PROGRAM

Like many other states throughout the nation who are facing increasing demands for the use of limited resources and with a great concern for the quality of life, the Legislative Assembly responded by enacting the 1973 Oregon Land Use Act; commonly referred to as Senate Bill 100.

Senate Bill 100 created the Land Conservation and Development Commission [LCDC] and its administrative arm, the Department of Land Conservation and Development [DLCD].

Overall, Oregon's program is based on two major components: the shared authorities and responsibilities of LCDC, local governments, and state agencies as set forth under SB 100, and other special-purpose statewide statutes. Described first are the two key elements of Oregon's program established by SB 100.

Senate Bill 100

Oregon's 1973 Land Use Act [SB 100] provides for coordinated comprehensive land use planning through the establishment of state standards and review.

The Act requires that each city and county develop a coordinated comprehensive plan, zoning and subdivision ordinances, which are in conformance with the adopted Goals and Guidelines. State agency and special district plans and actions must also conform with the Goals and local comprehensive plans.

Other functions of LCDC as set forth in SB 100 are:

--to review plans for conformance with statewide Goals;

--to hear and resolve appeals regarding possible conflicts of plans or actions with statewide Goals;

--to coordinate planning efforts of state agencies to ensure conformance with statewide Goals and local comprehensive plans; and

--to ensure citizen involvement in all phases of the process.

Goals and Guidelines

To guide comprehensive planning, the 1973 Act directed LCDC to adopt planning Goals and Guidelines. These planning Goals are regulations, intended to carry the full force of authority of the State to achieve the purposes of the Act.

Guidelines are suggested directions that would aid in achieving the mandated Goals. They are intended to be instructive, directional, and positive; but do not limit governments to a single course of action when some other course would achieve the same result.

The Goals and Guidelines are to be used by state and federal agencies, cities, counties, and special districts in preparing, adopting, revising, and implementing comprehensive plans.

In December 1974, LCDC adopted 14 planning Goals and supporting Guidelines which apply to the entire State. The first two Goals speak to citizen involvement and the process of developing coordinated comprehensive land use plans. The remaining Goals address specific resource elements or uses: Agricultural Land; Forest Lands; Open Spaces, Scenic and Historic Areas, and Natural Resources; Air, Water and Land Resources Quality; Areas Subject to Natural Disasters and Hazards; Recreational Needs; Economy of the State; Housing; Public Facilities and Services; Transportation; Energy Conservation; and Urbanization. This group of goals, due to their prescriptive and instructive characteristics:

--provide definitions of and designate resources, functions and areas deserving particular attention;

--specify the factors and considerations to be documented in plans;

--establish provisions for selection of allowable uses of resources by articulating criteria and priorities for uses or conditions to be maintained, enhanced, preserved, developed or conserved;

--set forth minimum procedures and requirements for justifying specific actions and for developing and implementing plans;

--allow exceptions subject to specified conditions and documentation of supporting evidence; and

--require the involvement of other management entities in plan development through coordination processes.

Coordinated Comprehensive Plans

Senate Bill 100 sets forth as legislative policy the necessity for properly prepared and coordinated plans. These comprehensive plans, which are expressions of public policy, establish the basis for specific local government rules, regulations, and ordinances, which must be consistent with and designed to implement the individual plans. Procedures exist for reviewing and, as necessary, revising the comprehensive plans to keep them consistent with the changing needs and desires of the public.

The completed plan will serve as the single, common basis for decisions regarding conservation and development in that area. In order for plans to be adequately coordinated and considered complete, city, county, state and federal agency, and special district plans and interests must be incorporated into and be consistent with the comprehensive plans. The planning process which will highlight conflicts, will not be complete until all affected agencies have resolved their differences and agreed to the comprehensive plan.

Development of these plans will require time and commitment on the part of all affected agencies, but once this basic agreement has been reached, time and funds can be saved in obtaining review and decisions on specific projects or decisions on investments. Public agencies, private firms, and individuals will be able to rely on the plan in making decissions and investments. Public investments in water and sewer systems, schools, etc. can be made in an orderly manner, in keeping with the ability to pay for them. Businesses can invest in new sites, confident that they will be used for their intended purpose and that the needed services will be provided. And, unnecessary delays in state and federal agency review of permit applications, as well as development of land management plans and public works projects, can be avoided because the key decisions will have been agreed upon in advance through the comprehensive plan.

Need For Coordinated Comprehensive Plans

Within the meaning of the coordinated comprehensive plan established by SB 100 is a challenge to past traditional planning concepts and methodologies. Specifically, the definition of the coordinated comprehensive plan has been established as follows:

> "Comprehensive Plan" means a generalized, coordinated land use map and policy statement of the governing body of a state agency, city, county, or special district that interrelates all functional and natural systems and activities relating to the use of lands, including but not limited to sewer and water systems, transportation systems, educational systems, recreational facilities, and natural resources and air and water quality management programs. "Comprehensive" means all-inclusive, both in terms of the geographic area covered and functional and natural activities and systems occurring in the area covered by the plan. "General Nature" means a summary of policies and proposals in broad categories and does not necessarily indicate specific locations of any area, activity or use. A plan is "coordinated" when the needs of all levels of governments, semipublic and private agencies, and the citizens of Oregon have been considered and accommodated as much as possible. "Land" includes water, both surface and subsurface, and the air.

The need for coordinated comprehensive plans has grown out of and rests upon a framework of old and new programs, as well as increased experience and knowledge.

In the past, under a number of planning programs, either initiated or supported at the local, state, and federal level, we have witnessed the development of a great number of so-called comprehensive plans. Yet, many, if not most of these plans were actually single or in some cases, multiple-purpose plans because their scope emphasized the subject(s) and range of interests and authority possessed by plan formulators. A widely known example of this has been the variety of plans developed by local, areawide, and state agencies under the Housing and Urban Development Department's 701 planning program. Here plans have been developed for sewer and water systems, open space and recreation, transportation, etc. Most recently, a land use element requirement has been established under this program. At the state level, a number of federal mandates provide support for other planning programs. Examples here include air and water quality and waste management plans supported by the Environmental Protection Agency and developed by state or areawide pollution control agencies. Another example includes state comprehensive outdoor recreation plans supported by the Bureau of Outdoor Recreation.

Correspondingly, there are a number of reasons that argue for both greater comprehensiveness and coordination of planning. For instance, in a recent study exploring the integration and coordination of environmental planning and management in state government, the follow three factors were identified as supporting the increased need for coordination.[1]

First, as awareness of environmental problems has grown it has been increasingly recognized that natural systems are interrelated in a complex manner and that adjustments in one system have consequences, usually unanticipated, for other systems. This means that pursuit of solutions to one environmental problem creates new problems. The conclusion drawn is that individual problems can not be resolved independently of one another and that a comprehensive perspective is needed.

A second factor is the proposition, accepted by many but not yet practically defined, that the environment as a whole has a limited carrying capacity wherein the intensity and distribution of activities and resource uses may be planned to achieve a balance between conservation and development. This implies that there is a definite limit on the growth and development which can be supported in a given geographic region. With a great number of federal, state and local programs which directly and indirectly support growth and development, the need to reconcile goals and objectives of these programs with environmental concerns requires coordination.

The third factor is based on a major administrative concern of all levels of government over the rapid proliferation of single-purpose programs and the need for a more rational organization of planning, increased efficiency and accountability, and a simplification of administrative procedures and requirements.

The definition cited above indicates that a plan is "coordinated" when the needs of all levels of governments, semipublic and private agencies and citizens have been considered and accommodated as much as possible. Failure to coordinate the concerns of all affected persons and groups means that the planning process may fail to resolve competing and conflicting interests in making resource allocations and designating land uses.

Based on these observations, the need for coordination within the context of planning is apparent and growing, particularly when planning itself is viewed as

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[1] Integration and Coordination of State Environmental Programs, The Council Of State Governments -- September, 1975

an allocation and decision making process. This directly relates to the very core topic of the symposium; that is, the resolution of conflicts between the diverse demands for finite resources.

To really identify the need for coordination, however, it is also important to note that conflicting interests are inherent to land use planning. This is for two reasons: first, use designations [allocation of resources] maximizing public and private benefits [minimizing public and private costs] are often at odds; and second, the differnet levels and units of government possess different perceptions of what mix of land uses best fulfills the public interest.

The first level of conflict in the use designation process is between a local government making use designations and affected citizens. The conflict itself is the result of differences in the use desired by the individual citizen or property owner and the use desired by the community as established by the local government.

The second level of conflict is between local governments--with geographically defined jurisdictions--and state and federal agencies possessing functionally defined jurisdictions. While local governments have planning responsibilities that cover all land uses in a specific area, administrative agencies regulate or develop specific uses bounded by state or national borders.

These responsibilities and interests conflict whenever a particular land use increases the welfare of a local area but at the same time is inconsistent with the regional, state, or national interests carried out by an administrative agency. Similarly, interests would conflict where agency regulation or development pursued in the regional, state, or national interest decreased the welfare of a local area.

With regard to instream flow needs, if we artificially separate our views of water and land related aspects, this second level of conflict possesses an added dimension creating an even greater need for comprehensiveness and coordination of planning efforts. Here most water-related authority for decisions are the responsibility of state and federal agencies and most land-related authority has been exercised by local governments. Because no single governmental unit has full responsibility for management and regulation of the resource base, decisions over local versus more centralized control provide the major source of conflicts.

Many of these conflicts can be eliminated or more quickly resolved if procedures are adopted ensuring that: (1) agencies and local governments making plans that develop land or regulate land use involve affected citizens, especially property owners in the planning process; (2) conflicts between governmental units are indentified in the planning stage rather than in the implementation or construction stage; and (3) recognized mechanisms for mediating and arbitrating serious conflicts are readily available.

Involving affected citizens in the use desingation process would achieve compatible plans by identifying and considering the interests of all affected private interests. In this way, local governments and state and federal agencies would more properly weigh the benefits and costs of designating a particular use for any given site or area.

Identifying intergovernmental conflicts in use designations at the planning level will eliminate or reduce them or their magnitude. At the planning stage, both agencies and local governments have devoted fewer resources and thus have made less substantial commitments to specific locations for particular land uses. At this stage of the process both parties should have reasonable alternatives to their first choices. Assuming the parties are relatively indifferent between at least two use designations or locations, then there is a greater likelihood that compatible decisions can be reached.

The purpose of the third step is to reduce the amount of time spent mediating and ajudicating unresolved conflicts. To be effective, a system for resolving conflicts must include standards and a process of making decisions. LCDC's Goals and Guidelines provide the beginnings of both. Accordingly, in the next section is a description of how the planning process can provide for incorporation of instream flow need concerns into coordinated comprehensive plans.

INSTREAM FLOW NEEDS AND COMPREHENSIVE PLANS

The focus of this section is on the nature of conflicts relating to instream flow needs and the comprehensive planning process. By way of providing an example, reference is made to a situation in a geographic area of Oregon's coastal zone. Particular emphasis is given to the steps or phases of the planning process and specific provisions of three adopted goals are identified because of their relevancy to instream flow needs. Finally, intergovernmental cooperation and coordination in developing plans is discussed.

Instream Flow Needs

Briefly stated, the problem giving rise to instream flow needs exists because there are multiple and competing values and interests involved in allocating water to consumptive or non-consumptive uses.

Consumptive uses, such as water used for domestic, municipal, industrial and agricultuarl purposes require the direct diversion of water from a water body. Non-consumptive uses, such as the amount of water needed to maintain the biophysical environment critical to aquatic life, recreation and aethetics, do not require diversion. Rather, the need is one which requires the assurance that a necessary and sufficient volume of water is maintained in the water body to support these uses.

Within Oregon's coastal zone, the major consumptive uses of water are for municipal, industrial and irrigation purposes while maintenance of aquatic life and recreational use are the major nonconsumptive uses of water. In regard to the supply of water studies, conducted by the Oregon Water Resources Department,[1] indicate that on an annual yield basis, there is sufficient water to satisfy all existing and future needs for designated beneficial uses.

Water availability, however, is constrained by seasonal distribution characteristics where requirements in excess of seasonal flows results in insufficient supply in many of the coastal streams during the low flow summer months. This supply problem is also compounded, in many locations, by limited supplies of potable groundwater.

Such problems are further complicated by the fact that low flows in many streams occur during the July through October period. These months generally are those of highest water use when the available supply must meet greater demands from increased summer populations and municipal, industrial and agricultural uses. This results in stream flows that are less than the minimum flows needed to sustain aquatic life and support water-based recreation.

When these low flow occur, there is an insufficient amount of water to meet the needs consisting of present legal appropriations and the minimum flows recognized as needed to sustain aquatic life. Thus, the combination of natural flow occurrence and level of use under legally established water rights determine the amount of water available for future use.

The Planning Process

The purpose of LCDC's adopted Land Use Planning Goal [#2] is to establish a land use planning process and policy framework as the basis for all decisions and actions related to use of land and to ensure an adequate factual base for such decisions and actions.

The goal provisions establish the following steps or phases of the process:

1) identification of issues and problems;

[1] Freshwater Resources of the Oregon Coastal Zone - December 1974

2) development of inventories and other factual information;

3) evaluation of alternative causes of actions;

4) adoption of policy choices and the plan; and

5) implementation.

While all of the goals [listed pages 2 & 3] may be viewed as being interactive, and they are, the specific provisions of two goals directly relate to the topic of instream flow needs because they address both consumptive or non-consumptive water use.

Non-consumptive water use and related aspects are covered by Goal #5. The objective of this Goal is to conserve open space, and protect natural and scenic resources. Various selected provisions of the Goal are as follows:

1) Programs shall be provided that will:
   a) protect scenic areas and natural resources for future generations; and
   b) promote healthy and visually attractive environments in harmony with the natural landscape character.
2) The location, quality and quantity of the following resources shall be inventoried:
   a) fish and wildlife areas and habitats; and
   b) water areas, wetlands, watersheds and groundwater resources;
3) Where no conflicting uses for such resources have been indentified, such resources shall be managed so as to preserve their original character. Where conflicting uses have been identified the economic, social, environmental and energy consequences of the conflicting uses shall be determined and programs developed to achieve the goal.

Consumptive use aspects, basically the provision of water supplies, are addressed in Goal #11. Its objective is to plan and develop a timely, orderly and efficient arrangement of public facilities and services to serve as a framework for urban and rural development. Specific provisions of this goal are as follows:

1) Urban and rural development shall be guided and supported by types and levels of urban and rural public facilities and services appropriate for, but limited to, the needs and requirements of the urban, urbanizable and rural areas to be served. A provision for key facilities shall be included in each plan.
2) A timely, orderly and efficient arrangement refers to a system or plan that coordinates the type, location and delivery of public facilities and services in a manner that best supports the existing and proposed land uses.
3) Key facilities are basic facilities that are primarily planned for by local government but which also may be provided by private enterprise and are essential to the support of more intensive development. [key facilities include water supply facilities]

Intergovernmental Coordination in Plan Development

Under Oregon's Land Use Planning Program the cities and counties act as the agencies to consider, promote, and manage local considerations of land conservation and development for the best interests of the people within their jurisdiction. In addition, the county has the primary responsibility for coordinating the plans within its jurisdiction. As was discussed earlier, state, as well as federal agencies, generally have functional roles and responsibilities within the borders of the state and nation rather than comprehensive responsibility for an area such as a county.

These relationships and the fact that resources, patterns of use and management problems do not correspond to the jurisdictional boundaries of local governments necessitate close intergovernmental coordination in plan development.

By refering to the statutory responsibilities of a selected state agency which correspond to topical provisions of the Goals cited and proceding step by step through the planning process, we can describe how coordination can be achieved. [A similar process is possible for other state, as well as federal agencies.]

The Water Policy Review Board and the Oregon Department of Water Resources determine the public interest in water resource issues and establish state policy through adoption of program statements. These policy statements set minimum flows to remain in the streams, classify unappropriated water for the highest and best uses in the future and formulate guidelines for development and augmentation of Oregon's water resources.

Basically, state water policy is a guideline for future use. In concept, policies for water are not too different from land use plans. Estimates of water availability, use under existing water rights, and projected needs are all considered in prescribing allowable uses of specific streams or basins.

Administration of the appropriation and use of surface and groundwater is also a responsibility of the department. The department issues and records permits, conducts field surveys, issues water right certificates, handles transfers and cancellation of water rights, initiates adjudication proceedings and determines critical ground water areas. On its own and in cooperation with other agencies, the department conducts investigations of the availability and use of both surface and ground water.

In the first two steps of the planning process, a state agency, such as the Water Resources Deparment, could greatly assist local government by providing assistance in the identification of problems both within and affecting particular jurisdictions. Inventory data, as well as the expertise to interpret the data, could also be provided. This would be particularly important in identifying resource capabilities to support consumptive and non-consumptive uses and related values [aquatic life, recration and aesthetics] by projecting the intensity and geographic distribution of demand for these uses.

The third and fourth steps, that of evaluation of alternative courses of action and adoption of policy choices and the plan, require negotiation and mutual accommodation. Here the impacts and consequences, as well as the costs and benefits of an alternative have to be weighed. Too, trade offs between values and uses are inevitable but compromise is necessary if conflicts are to be resolved. However, once they are established uncertainty over future events is reduced. When this point is reached, then both the local comprehensive plan and the policy plan of the Water Resources Department would be consistent with each other.

Finally, during the implementation phase, both the local unit of government and the Water Resources Department could act with confidence and assurance because there is basic accord on the decisions that have been made.

To return to the example of water allocation conflicts in Oregon's coastal zone, which are increasing and where development of storage capacity that does not impact significantly on the anadromous fishery seems to be the only viable solution, local government would be assured that the water supply necessary for future development would be available because in the plan, the location of sources and the necessary facilities for storage and distribution of water will have been agreed upon in advance of the time of actual need. This is what the coordinated comprehensive plan is all about.

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A SYSTEMATIC APPROACH TO THE STRATIFICATION OF THE VALLEY BOTTOM AND THE RELATIONSHIP TO LAND USE PLANNING

Albert Wm. Collotzi
Fishery Biologist
Bridger-Teton National Forest
Jackson, Wyoming 83001

ABSTRACT

The Valley Bottom concept has resulted in the stratification of the valley bottom into identifiable units of land that are mappable, describable and predictable. This system provides for a hierarchical system which permits a choice of the degree of detail required to meet the purpose of a particular planning or decision level.

The Valley Bottom concept provides a method for incorporating instream flow needs into the land use planning process at several levels of planning. These include the Valley Bottom Association, Valley Bottom Type and the Valley Bottom Type Phase. The most important level in this hierarchical system is the Valley Bottom Association. The systematic approach to the stratification of the Valley Bottom for the first time allows all resources within the valley bottom to be evaluated simultaneously on an equal basis with other resources and land management activities.

INTRODUCTION

The advent of the National Environmental Policy Act (land use planning) has had a greater impact upon fish and wildlife resources than any other single event since state and federal agencies began the managing of these resources. There has been consideration in the past, but it is the first time these resources have been evaluated simultaneously on an equal basis with other resources and land management activities. No longer is one resource or activity considered by itself for a given piece of land. A resource activity may be more important or given dominance over others, but each resource has to be evaluated and the alternatives considered. In order to properly evaluate the resources and activities that may be found upon a piece of land, each must have a common denominator. Arnold (1976) in his report on "The Idaho Batholith" emphasized the need for such an approach and identified most of the basic problems that need to be solved.

Several attempts have been made to provide this common denominator. Wertz and Arnold (1972) developed the Land Systems Inventory which was primarily an abiotic approach with a little biotic consideration. On the other hand the Habitat Type concept as described by Daubenmire (1968) was basically a biotic approach with a little abiotic. In 1973, a multidisciplinary team attempted to develop an ecosystem classification (Ecoclass--A Method for Classifying Ecosystems) which was to provide the common denominator. The system did provide a unified approach that could be used within each discipline but failed to place the disciplines on a common ground with one another. It was basically an overlay system. An attempt by Platts (1974) to develop a system which linked the aquatic resource to specific geologic and geomorphic settings was fairly successful. Although the concept was good there were several weaknesses in the system. Because of the complexity of the system it was difficult to communicate between biologists and between the biologist and the land manager and other resource managers. In addition, the system does not provide a common link between the aquatic resource and adjacent resources.

Cole, some time after 1972, developed a method ("Valley Types, An Extension of the Land Systems Inventory to Valleys") for delineating and characterizing valleys to aid land use planning. This method is based on the same basic assumptions as the Land Systems Inventory (Wertz and Arnold, 1972) and was primarily abiotic. His system also contained the weaknesses found in Platt's work.

The U.S. Fish and Wildlife Service (1976) in their "Interim Classification of Wetlands and Aquatic Habitats of the United States" presented a program for classifying wetlands and aquatic habitats. This system does not attempt to relate these resources to resources of adjacent lands nor does it include the entire valley bottom.

In 1974 the author, with assistance from other Interdisciplinary Team members on the Bridger-Teton National Forest, presented an approach for the stratification of the Valley Bottom (Collotzi, 1975) to be used for the aquatic resource. Since that time the author, utilizing the expertise of the Forest Hydrologist (A.F. Galbraith) and Soil Scientist (Bill Glenn), has refined and expanded the approach to include a total system, which allows all disciplines to relate to the valley bottom. In addition the system is interrelated and compatible to the present Land Systems Inventory.

In most inventories the valley bottoms have not been given full consideration. Mapping has been done at a level which did not recognize most valley bottoms. Therefore, the lesser stream bottom lands were often lost in the larger land masses. Cole, in his report, states: "Valleys include some of the most sensitive portions of the landscape insofar as their response to disturbance. They are also the part of the landscape that receives the greatest use by man. We build most of our roads, trails, campgrounds, and buildings in the valleys. Many species of wildlife and fish are dependent for at least part of their annual life cycle on mountain valley habitat. Stream and water qualities are determined to a great extent on what takes place in the valleys. Land use planning must recognize and provide for the qualities of valleys if management is to achieve its objectives."

A SYSTEMATIC APPROACH

The inventory of the various resources must be made at different levels and intensities in order to fit the needs of a given level of planning. If the level of planning is broad, the level of inventory must be broad. If the level of planning deals with a specific project then the inventory must be more specific.

Bailey, 1976, in his work "A Regional Approach to Ecosystem Classification for Purposes of Resources Inventory -- An Initial Effort", emphasizes the need for a hierarchical system which permits a choice of the degree of detail required to meet the purpose of a particular planning or decision level. Arnold (1975) presented a similar view and recognized that such a system was needed for aquatic and wildlife resources. In principle, the problems associated with aquatic and wildlife resources are no different than those found in other resources.

The approach presented by the author emphasizes the importance of the valley bottom as a recognizable unit of land. The concept of the valley bottom is very simple, but must be defined. The valley bottom is described as that area of land that has been formed as a result of water related processes, glacial activity, and/or may be influenced by the present stream. In most cases, it will be that area between the two toe slopes.

Hierarchical System

The hierarchical system proposed by the author includes four levels starting at the lowest level, the landtype phase, and progressing upward to the subsection. The scope of this paper does not go beyond the subsection. Table 1 is a summary of each level.

TABLE 1. A Hierarchy for the Valley Bottom Stratification

	Name	Defined as Including
IV	Subsection	Major lithological areas such as Granite, Hard and Soft Sedimentary formations, gross morphology and kinds of process, etc.
III	Valley Bottom Association	Valley bottom type as determined by gradient.
II	Valley Bottom Type	Group of neighboring units within a valley bottom, such as stream, alluvial fan, terrace, lake, etc.
I	Valley Bottom Phase	Vegetative or community type, pools, or riffles, beaver pond, etc.

The following is a discussion of each of the four levels from the more general to the more specific.

Subsection (Level IV)

The subsection is primarily a geological classification based on parent rock material. Another important factor has been past climatic conditions. This factor has been responsible for glacial and alluvial processes which have been important in the characterizing of these valley bottoms. Other processes which have played a lesser role are colluvial and mass movement.

The geological classification at the present time includes four kinds of rock: granite, hard and soft sedimentary, and flows. these are defined as follows:

Granite: Includes all pre-Cambrian rocks, chiefly granite, but also includes metasedimentary rocks (gneiss and schist). Produces coarse sediments.

Hard Sedimentary: Paleozoic rocks. Well consolidated, contains high proportion of hard sandstone, limestone and dolomite. Not high sediment producers.

Soft Sedimentary: Mesozoic and Cenozoic rocks. Poorly consolidated, high frequency of mass movement. Contains many soft plastic shales. High sediment producers -- much suspended sediment.

Flows: (Basalt-rhyolite, etc.) Fine grained igneous rocks occurring in large sheets.

This level in the hierarchy is flexible enough to add other geologic groups where necessary or desirable to explain stream differences. Planning at this level is very broad and long term. Information to be used for planning can be taken from good geologic maps.

Valley Bottom Association (Level III)

The Valley Bottom Assocation is the most important level in the hierarchical system. The approach used by the author depends upon the valley bottom being recognized as an identifiable and important association. In the past only a part of the valley bottom has been identified as an association. These were large units classed as Depositional Lands by the soil scientist (alluvial deposits). The many smaller units were not mapped. Valley bottoms outside of the Depositional Lands in the past have been used only as boundaries between other associations. The proposed system recognizes that all valley bottoms can be divided into associations. This system stratifies the valley bottom into identifiable units of land that are mappable, describable and predictable (Figs. 1, 2, 3, and 4). In addition, these units can easily be recognized by the land manager as well as the biologist.

Three Valley Bottom Associations have been described and a fourth is being considered. One of the primary differences between these associations is stream gradient. Each can be easily identified in the field using a hand level. If field time is limited the associations can be mapped using resource photographs (1:15,840) and Geological Survey Maps (7.5 minute series - topographic). Later as time allows, field checks can be made.

These associations are found in all of the subsections described above and at times cross from one subsection to another. In this case the association is the product of both subsections and can be so described. A more detailed description of these associations are as follows:

Steep Gradient Valley Bottom Association (Fig. 2)

Stream segments located in this association have an overall gradient greater than three percent. This association is seldom connected with large alluvial deposits (depositional lands). These valley bottoms are narrow with steep slopes generally on either side; however this does not always hold true at higher elevations. Streams are almost always constricted by these slopes and are prevented from meandering throughout a valley floor. The action of the streams in this association is one of cutting and the transporting of materials to other associations.

The soils in these valley bottoms are commonly shallow, forming a thin mantle over bedrock. In some areas the streams are cutting into this bedrock. Cutting is also taking place in slump material and glacial debris depending upon the location of the stream. These soils support a variety of plant communities, including sagebrush/forb/grass, shrub/forb and mixed conifer and aspen with shrubs. Most of the slopes either support a conifer type community, or an aspen, sagebrush, grass or forb community, depending upon the aspect of the slope.

Stream bottom composition may vary from stream to stream, but in general it is fairly constant. Expected composition is as follows:

Bottom Material Diameter	Percent Parent Rock	
	Granitic	Sedimentary
Boulder (30.5 cm)	50 to 70	30 to 60
Rubble (7.7 cm to 30.5 cm)	5 to 30	35 to 60
Gravel (3.2 mm to 76 mm)	5 to 15	5 to 30
Sand-Silt (3.2 mm)	0 to 15	0 to 10

Intermediate Gradient Valley Bottom Association (Fig.3)

The stream segments located in this association have an overall gradient between two and three percent. Nearly all of these valley bottoms are associated with alluvial deposits. Gradients are such that materials carried by the streams are both deposited and removed from the valley bottom. Most of the materials in these bottoms were deposited at an earlier time. The overall action of the streams in these bottoms is one of cutting, although in some areas this is difficult to recognize.

The soils in these valley bottoms are commonly deep, but not as deep as those found in the Low Gradient Landtype Association. Stream channels are generally banked by old depositional gravels and sand and mud bars. Much of the stream banks are very wet and subject to periodic flooding during spring runoff, but become dry as the summer progresses. Soil textures range from fine to coarse loamy with the finer textured soils (increased clay content) being derived from sedimentary rocks. The coarse textured soils (increased sand content) were noted to have been derived from granitic rock. These soils primarily support dry meadow complex communities, and some sagebrush communities with scattered patches of aspen and conifer. The remaining 30 to 40 percent of the alluvial bottom consists of coarse loamy, rocky soils with up to 60 percent rock in the lower portion of the profile. These we-l-drained soils support a sagebrush/forb/grass community with scattered and small patches of conifer.

Stream bottom composition may vary from stream to stream, but in general, it is fairly constant. Expected composition is as follows:

Bottom Material Diameter	Percent Parent Rock Granitic	Sedimentary
Boulder (30.5 cm)	15 to 40	10 to 40
Rubble (7.7 cm to 30.5 cm)	30 to 50	25 to 70
Gravel (3.2 mm to 76 mm)	10 to 40	10 to 45
Sand-Silt (3.2 mm)	5 to 40	0 to 25

Low Gradient Valley Bottom Association (Fig. 4)

Stream segments have an overall gradient less than two percent. All of these valley bottoms are located in areas of large alluvial deposits. Gradients are such that materials carried by the streams are being deposited in the valley bottom. This has resulted in the development of wide flood plains as the stream meanders across the valley floor.

The soils in these valley bottoms are commonly deep with soil depths to 25 feet plus, not uncommon. Stream channels are immediately banked by depositional gravels and sand and mud bars. Much of the streambanks, and probably as much as 60 to 70 percent of the alluvial bottoms are very wet and subject to periodic flooding. Soil textures range from fine to coarse loamy with the finer textured soils (increased clay content) being derived from sedimentary rocks. The coarse textured soils (increased sand content) were noted to have been derived from granitic rock. The wetter soils support wet meadow communities. The remaining 30 to 40 percent of the alluvial bottom consists of coarse loamy, cobbly soils with up to 60 percent rock in the lower portion of the profile. These well-drained, drier soils support a sagebrush/forb/grass community with scattered small patches of conifer.

Bottom composition may vary from stream to stream, but in general, it is fairly constant. Expected composition is as follows:

Bottom Material Diameter		Percent Parent Rock Granitic	Sedimentary
Boulder	(30.5 cm)	0 to 30	0 to 20
Rubble	(7.7 cm to 30.5 cm)	10 to 50	25 to 60
Gravel	(3.2 mm to 76 mm)	25 to 55	20 to 55
Sand-Silt	(3.2 mm)	25 to 45	0 to 25

Valley Bottom Type (Level II)

The valley bottom types in this system are the same in concept as the landtype described by Wertz and Arnold (1972). "Landtypes are the basic units and building blocks for overall land use study and planning. They are the visually identifiable unit areas resulting from homogeneous geomorphic and climatic processes and having defined patterns of soils and vegetative potentials. Landtypes range in size from about 1/10 to 1 square mile. Their size and composition depend upon the significance of physical characteristics which can be readily interpreted to identify hazards, suitabilities, and productivity potentials that are reliable for area planning purposes. They are areas of land generally managed as an entity and as such identify areas for which zoning and resource allocation decisions can be made. Landtypes delineate the permanent elements of the ecosystem and serve as a logical base and frame of reference for which other elements of the ecosystem can be described.

"Landtype delineations and descriptions correspond with what can be readily observed in the field, permitting rapid understanding by land managers, facilitating extrapolation of experience and research to similar areas of land, enhancing continuity of management with changing personnel, and promoting consistent management within organizations."

The primary difference in the above landtype and the valley bottom type as proposed by the author is the size of the unit to be considered. The landtype has been limited from 1/10 to 1 square mile, the valley bottom type is not limited by size. In addition to this difference, the valley bottom type includes streams and lakes and places them equal to land units. Using this system all land and water within a valley bottom is divided into types which make up the valley bottom association. (Fig. 1).

Valley Bottom Type Phase (Level I)

The phase in the hierarchical system is the lowest level for collection and development of planning information. The phase is used for detailed planning. This level in the system brings together all the abiotic and biotic components which constitute individual discrete ecosystems. Valley bottom type phases identify uniform land or aquatic characteristics as they occur within valley bottom types. The phase may be identified or defined using abiotic characteristics such as kinds of soil(s) or bedrock or by using biotic characteristics such as habitat type (vegetation).

The habitat type as used by the author is basically the same as described by Daubenmire (1968). In addition to the habitat type the community type will also be used. Much of the valley bottoms are subject to periodic changes and there is some question whether the climax species can be identified.

In order to have a complete system the aquatic environment of the valley bottom must be characterized. The phases found in the aquatic environment include pools and riffles in a stream, a beaver pond, a large marsh or a zone found in a lake.

INSTREAM FLOW NEEDS

The Valley Bottom concept provides a method for incorporating instream flow needs into the land use planning process. Instream flow needs can be determined at several levels of planning. These include the Valley Bottom Association, Valley Bottom Type and the Valley Bottom Type Phase. The Transect Method as described in "The Transect Method of Stream Habitat Inventory - Guidelines and Applications" by Dunham and Collotzi (1975) provides for the collection of data at these levels. To complement this method of inventory a computer program has been developed (General Aquatic Wildlife System) called GAWS (Collotzi and Munther, 1975) which is to be operational by the fall of 1976.

It is essential that instream flow determinations be made for all resources in the valley bottom. This requires involvement from disciplines other than just the fishery biologist. It is possible a flow needed to protect the aquatic resource will not be adequate for wildlife needs. Improper flows could change many of the present habitat types from a sedge/grass willow type to a sagebrush type, etc. Beaver, moose and waterfowl habitat could easily be eliminated or reduced.

Using the Valley Bottom concept it is important to determine instream flow needs in all three associations since the habitat found in each is considerably different. Investigation by the author during the past two years has resulted in 732 pools and their features being analyzed. The data indicates that nearly 50 percent of all the pools are located in the Low Gradient Association. Sixty percent of the Class 1 rated pools and 63 percent of the Class 2 rated pools were located in this same association. Pools associated with boulders were generally the poorest quality pools. Platts found this to be true in his study. Forty-nine percent of the pools in the Steep Gradient Association are associated with boulders. The results of Platts' work, if related to the author's system, would also indicate that most of the fish population is located in the Low Gradient Association. There is little doubt that similar situations will be found with wildlife habitat. As an example, 57 percent of all beaver dams were located in the Low Gradient Association.

DISCUSSION

Up until this time there has not been an adequate classification system developed that successfully considers all resources within the valley bottom simultaneously on an equal basis. Nearly all of the present systems fall into one or more of the following categories:

- The complexity of the system has made it difficult to use and therefore has not been accepted by the land manager.
- The system has been developed for a specific resource and does not give adequate consideration to other resources.
- The system has been primarily abiotic or biotic in its classification.

In addition, these systems have not tied the valley bottom into the land use planning process.

The valley bottom classification system as presented by the author provides for the interaction of all resources within the valley bottom. It includes both the abiotic and biotic environments in the classification and at the same time is not a complex system to use. This system stratifies the valley bottom into identifiable units of land that are mappable, describable and predictable. These units can easily be recognized by the land manager as well as the resource specialist.

The aquatic environment within the Valley Bottom Type Phase, the Valley Bottom Type and the Valley Bottom Association has been inventoried and characterized using the Transect Method. The level of planning determines the intensity of the inventory.

Although the basic concept of the valley bottom is sound, the author recognizes the need for continual testing and refinement of the valley bottom system. There is a need for additional information in many areas. Some of these needs are as follows:

- Many of the Habitat and Community types in the valley bottom have been described. There are many yet to be described and the keys developed for use in the field.
- Inventory guidelines need to be developed for the different levels of planning for all disciplines.
- Instream flow requirements need to be established to protect and sustain the various habitat types. These are particularly lacking in the wetlands.
- Incorporation of stream size may be necessary in the classification, but where and how much?
- Somewhere in the system geomorphic history needs to be incorporated. The question is where and how much, since the object of this approach is to keep the system simplified.
- A great deal of field testing is needed for refinement of the system.

CONCLUSIONS

The systematic approach to the stratification of the Valley Bottom as described in this paper presents a common denominator for all disciplines involved in the management and planning of these resources. This approach is compatible with present land classification systems and land use planning needs. It presents to the users several levels of identifiable units of land that can easily be recognized in the field.

Land use planning is a real part of our lives and will be for many years to come. The management of the resources of the valley bottom is essential. These resources must be displayed simultaneously on an equal basis with other resources on the adjoining landscape. Without a common frame of reference it is difficult if not impossible to evaluate the alternatives for the management of these resources.

BIBLIOGRAPHY

Arnold, J.F.

1975. The Idaho batholith - a sourcebook of information. Intermountain Region, U.S. Forest Service. 290 pp.

Bailey, R.G.

1976. A regional approach to ecosystem classification for purposes of resource inventory - an initial effort. Preliminary review draft. Intermountain Region, U.S. Forest Service, Ogden, Utah. 41 pp.

Cole, G.F.

1972. Valley types - an extension of the land systems inventory to valleys. Boise National Forest, Boise, Idaho. 14 pp.

Collotzi, A.W.

1975. A systematic approach to the stratification of the valley bottom (gradient) habitat type. U.S. Forest Service, Jackson, Wyoming.

Collotzi, A.W. and G. Munther

1975. General aquatic wildlife system (GAWS). Intermountain Region, U.S. Forest Service, Ogden, Utah.

Corliss, J.C. and R.D. Pfister

1973. Ecoclass - a method for classifying ecosystems. A task force analysis. Intermountain Station, U.S. Forest Service, Missoula, Montana. 52 pp.

Cowordin, L.M., V. Carter, F.C. Colet and E.L. LaRoe

1976. Interim classification of wetlands and aquatic habitats of the United States.

Daubenmire, R. and J.B. Daubenmire

1968. Forest vegetation of eastern Washington and northern Idaho. Wash. Agr. Exp. Sta. Tech. Bull. 60. 104 pp.

Dunham, D.K. and A.W. Collotzi

1975. The transect method of stream habitat inventory - guidelines and applications. Intermountain Region, U.S. Forest Service, Ogden, Utah. 98 pp.

Platts, W.S.

1974. Geomorphic and aquatic conditions influencing salmonids and stream classification -- with application to ecosystem classification. In Surface Environment and Mining Project Report. USDA Forest Service, Billings, Montana. 200 pp.

Wertz, W.A. and J.F. Arnold

1972. Land systems inventory. Intermountain Region, U.S. Forest Service, Ogden, Utah. 12 pp.

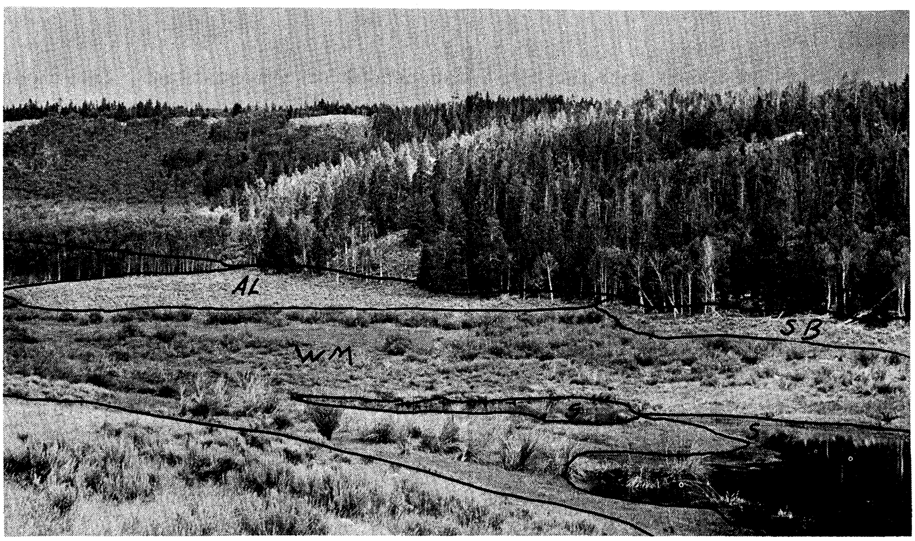

Fig. 1. A part of the valley bottom showing a low gradient valley bottom association and the valley bottom types within the association. AL-alluvial fan; WM-wet meadow complex; S-stream community with beaver dam phase showing; SB-sagebrush community.

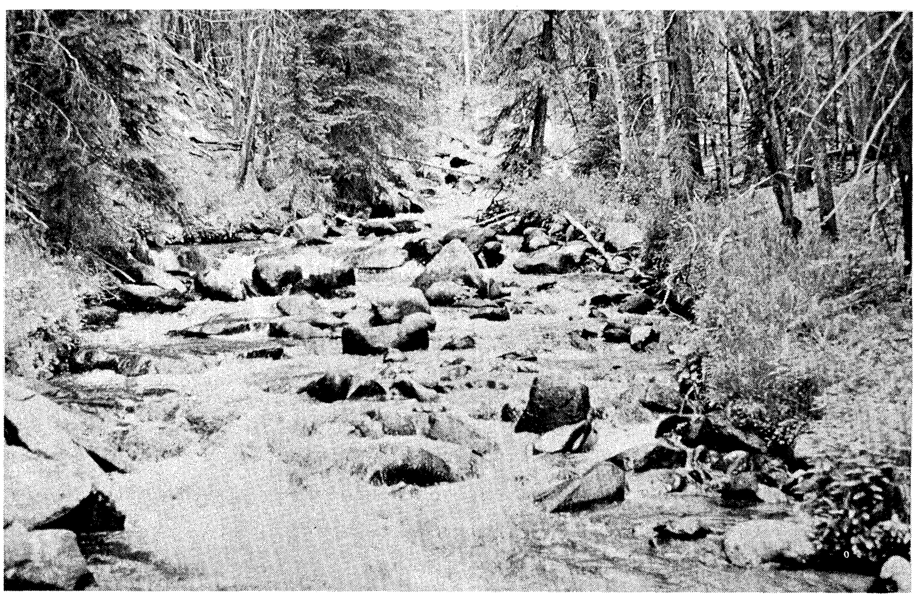

Fig. 2. Steep gradient valley bottom association on the Sweetwater River, Bridger-Teton National Forest

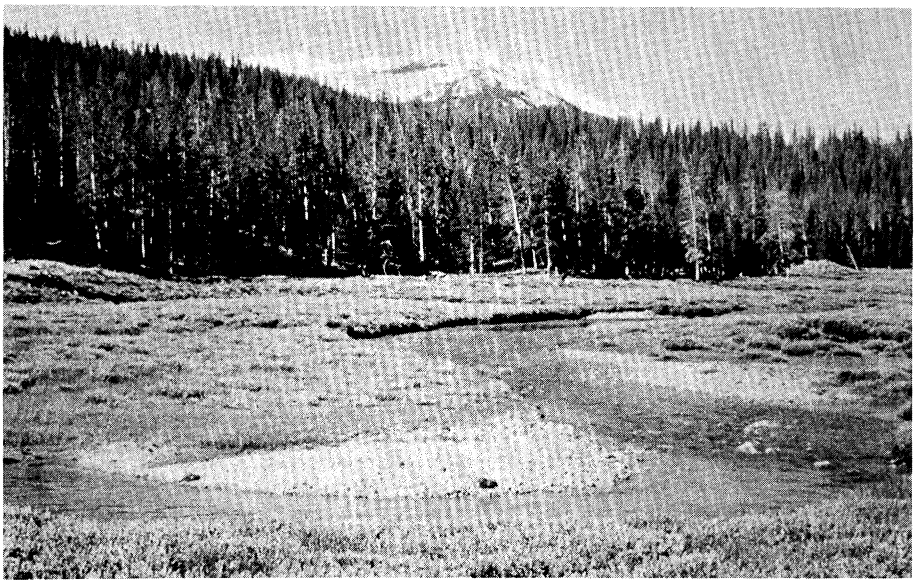

Fig. 3. Intermediate gradient valley bottom association on Shoal Creek, Bridger-Teton National Forest

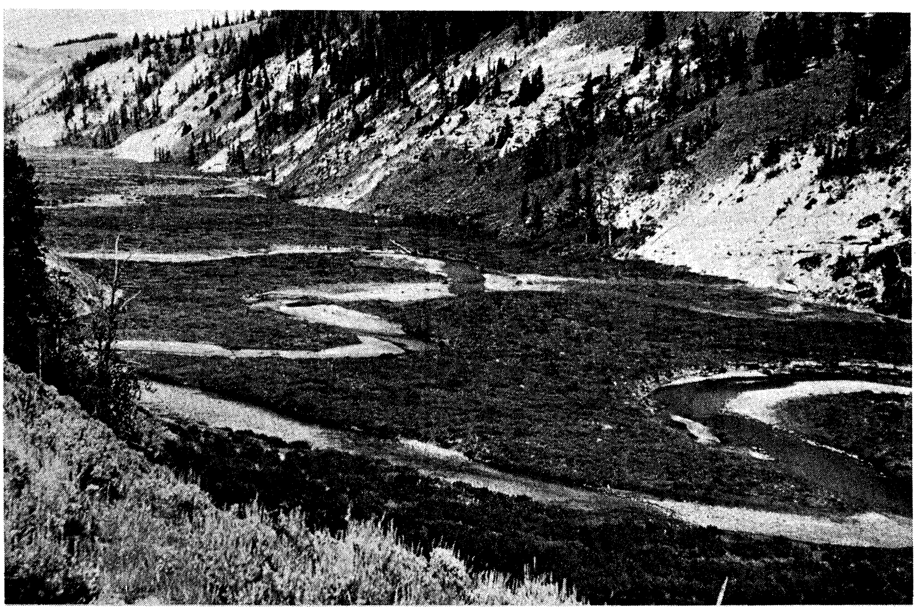

Fig. 4. Low gradient valley bottom association on Fish Creek, Bridger-Teton National Forest

WASHINGTON STATE'S SHORELINE MANAGEMENT ACT
ITS EFFECTS ON INSTREAM FLOW NEEDS

Miriam I. Laukers
Office of Land Programs
Department of Ecology
Olympia, WA 98504

ABSTRACT

Washington's shorelines are a valuable natural resource subject to growing and competing demands for their use. The Shoreline Management Act regulates development and other activities along the shorelines with the purpose of protecting the resources and amenities while promoting appropriate uses in suitable locations.

The Act is enforced through a permit system which requires all developments over $1,000 in value, if located on the shorelines, to obtain a permit from the local government in whose jurisdiction the project is located.

The Act applies to all marine shorelines and to lakes and streams over a certain size. The regulations promote water-dependent uses, recreational opportunities, and access to the water. They also protect water quality, aquatic and shore habitats and scenic values. The emphasis in the Act is to preserve, as much as possible, the natural character along shorelines of the state consistent with long-range public interests.

INTRODUCTION

The Shoreline Management Act of 1971 was passed in response to pressures brought by citizens because of rapidly increasing shoreline development.

Its thrust is towards land use along shorelines, not towards allocation of water or managing its quality. However, indirectly through controlling man's activities on shorelines and in water areas, it can substantially influence water's use as well as its quality.

First, I will give briefly the history of the Shoreline Management Act, then discuss how the program works, and, finally, try to analyze what has been accomplished so far. Where appropriate, I shall relate the discussion to instream flow needs.

SHORELINE MANAGEMENT ACT - WHAT IS IT?

History

It all started with the court case Wilbour vs. Gallager in 1969, when the court ruled that a fill in Lake Chelan was illegal and had to be removed because it interfered with the public's right to use navigable waters.

The decision created uncertainty for shoreline development and stimulated activity on part of both environmental groups and the Legislature, which ultimately led to the passage of the Shoreline Management Act.[1] The Legislature authorized, effective immediately, a permit system to regulate all substantial shoreline developments. This means that the Shoreline Management Act has been in full effect and functioning since June 1971.

Scope

Washington's Shoreline Act has wide applicability because it covers all marine shorelines, all lakes over 20 acres in size, and all streams with over 20 cfs average annual flow.

The shoreline area is defined as all the water areas of the eligible water bodies, together with a 200-foot wide strip of shoreland running parallel to the water. Included are also associated flood plains, marshes, swamps, and bogs.

According to the shoreline inventories, there are almost 16,000 miles of stream shorelines throughout the state under jurisdiction of the Act, measuring both sides of a stream.[2]

The Act applies to both private and publicly owned lands, with the exception of federally owned and Indian lands.

Objectives

The Legislature found that "the shorelines of the State are among the most valuable and fragile of its natural resources, and that there is a great concern throughout the State relating to the utilization, protection, restoration, and preservation" (RCW 90.58.020). The shorelines were to be managed so as to protect against adverse effects to the public health, the land and its vegetation and wildlife, and the waters of the State and their aquatic life, and to protect public rights of navigation.

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1. RCW 90.58
2. The Act also applies to 2,400 miles of marine and 2,300 miles of lake shorelines.

In order to appeal to a broad citizen base, the legislators tried to provide a balance between economic development and the environment. In other words, the intent of the Act is not to prevent shoreline development, but to plan for and control shoreline activities with preference for uses which control pollution and prevent damage to the natural environment, or are dependent upon use of the State's shorelines.

HOW DOES IT WORK?

Planning and Program Development

The framework for shoreline planning was established by the policies in the Act. Based on these general policies, the Department of Ecology developed guidelines[3] which provided a more detailed set of policies aimed at specific shoreline related issues, mainly natural systems and various human activities which are commonly found on the shorelines.

The State's guidelines in turn were to help local governments develop their own shoreline management master programs, which are the backbone of shoreline management in the State. The Department of Ecology was only to provide initial guidance and technical help, and later to function in a review capacity to assure that the local programs are consistent with the Act.

There are 224 jurisdictions including 39 counties that needed their own shoreline programs. In some cases, the smaller towns adopted their county's program, but the major cities and also many small communities chose to develop their own.

Another facet of shoreline management mandated by the Act was a strong citizen involvement. Based on procedures outlined in the State's guidelines, local citizens were selected to help planning staffs develop the programs. These citizen advisory committees ranged in size from 3 to 60 members and were chosen to represent all types of interests. Statewide, about 2000 private individuals were actively involved in the development of the programs, possibly the most extensive such involvement in the whole United States.

The master programs reflect the unique shoreline conditions and the development requirements which exist or are projected to exist in that area. They are <u>general</u> in nature - policies and regulations are not directed to specific sites, and they are <u>comprehensive</u> - directed towards all land and water uses.

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3. WAC 173-16.

Management Structure

Shoreline management is planned and adminstered locally by each county and city with eligible shorelines within its boundaries. This, of course, means that the same stream and drainage basin may be administered by federal jurisdictions with somewhat different programs. To avoid conflicting local management, the State has acted as coordinator between the various jurisdictions, and the State also has to review and approve the programs.

Substantial Development Permits

The most important implementation tool for the Shoreline Management Act is the permit system. As stated before, since the first day of the Act, all substantial developments along Washington's shorelines have been required to obtain a Shoreline Substantial Development Permit; substantial development being defined as all developments that exceed $1,000 in value. There are some additional criteria and, also, several exemptions from the permit requirements, which I shall discuss later.

At first, development proposals were evaluated against the policies contained in the Act itself. After the State guidelines were developed, they provided additional criteria for review, but, as soon as a local master program was developed, even before its final approval by Department of Ecology, that master program provided the main direction for development.

The permits are also administered locally. A developer applies for a permit to the government in whose jurisdiction his site is located. After the local government reviews and approves the permit, it is forwarded to Department of Ecology for another review. If the Department finds the project inconsistent with the Act, the permit may be appealed to the Shorelines Hearings Board, but the Department cannot simply deny the permit.

The Shoreline Hearings Board.

The Legislature, in 1971, created a Shoreline Hearings Board, which is a quasi-judicial body of six members. Any person, organization, or agency aggrieved by a shoreline decision at any level, may appeal to this Board. A Hearings Board's decision may be appealed further to the courts.

Hearings Board rulings have provided additional criteria for evaluating shoreline development.

Effect on Instream Flow Needs

The shoreline programs contain both policies and regulations. The possible effects on instream flow needs, due to shoreline management practices, would appear at two levels: first, at the policy development level, and, second, at the project planning level caused by specific use regulations.

Shoreline regulations generally have a more direct effect on water quality and on use of water for water-related activities than on water consumption itself.

Policy Development

Environments

One of the policy planning tools used in shoreline management is the so-called "environments."

Throughout the state, local jurisdictions were required to designate their shorelines in four basic "environments" or planning areas. The four vary from intensively developed urban areas to almost natural shorelines. This system was intended to provide uniformity for the shoreline regulations throughout the state.

The planning area designations were based on existing development patterns, biophysical capabilities or limitations, and the goals and aspirations of the local citizens.

Each environment is intended to encourage the type and intensity of development which would best reflect the character of that environment and, incidentally, would override local zoning. This system may have an indirect effect on the instream flows by controlling where water consumptive uses will be located or where uses with a potential for detrimental effects on water quality may or may not be located. Usually, the more natural and unspoiled a stream segment may be, the more stringent development policies it will have.

Natural Systems

Additional policies are based on the characteristics of various natural systems.

Rivers, Streams, and Creeks

Policies recognize the multiplicity of human uses related to streams, and recommend that developers recognize and protect the natural hydraulic functioning of the streams, and the fish and wildlife which inhabit the water courses and their shorelines.

Flood Plains

Flood plains are another natural system that the Shoreline Management Act is concerned with. Recognizing the high potential for property damage due to floods, the policies for undeveloped areas recommend that flood plains be left as open space and used for recreation or agriculture. If development is to occur, structures must be flood proofed. In developed areas, where protective measures such as dikes are needed, the policies again discourage interference with the natural processes. Channelization of streams is to be avoided, and protective structures should not create a barrier between water storage areas, such as marshes, and the main course of the stream. As can be seen, these provisions have been borrowed from existing flood control programs.

Marshes, Bogs, and Swamps

Marshes, bogs, and swamps, when physically connected with a stream that is subject to the Shoreline Management Act, are also considered as part of shorelines because of their importance as wildlife habitats and as ground-water recharge areas and, also, for their value in flood control.

Again, the policies are aimed to preserve these places in a natural condition as much as possible, even in urbanizing areas.

Regulation of Shoreline Uses

All shoreline programs include regulations for specific uses. Streams of all sizes have always attracted man's activities. They are used for power production, transportation, recreation, and fisheries management. Their waters are needed for irrigation, industry, and domestic consumption. Streams also provide habitat for fish, animals, and waterfowl. All these uses either consume water, or contribute to its degradation, or both. The Shoreline Management Act provides controls over some of these activities.

Obviously, we have little influence over federal dams and power generation. Transportation may be indirectly influenced by regulations for log booming, dredging, dredge spoil disposal, and location of port and moorage facilities. Recreation is recognized as one of the preferred uses by the Shoreline Management Act, and so are water dependent industry and commerce.

Another group of uses - forestry, agriculture, and single family homes, all of them significant contributors to nonpoint source pollution are, to some extent, beyond the reach of Shoreline Management Act.

Forest Practices

Forest practices presently are regulated by two laws with overlapping jurisdiction - the Shoreline Management Act and the Forest Practices Act. Since the Shoreline Management Act preceded the other, the local master programs include forestry regulations, such as buffer requirements, to protect streams from siltation, pollution due to chemical application, and changes in water temperature. Other provisions deal with promoting sound forestry practices, proper road and bridge construction, and protection of scenic values. Along major streams designated by the Legislature as Shorelines of Statewide Significance, only selective logging is allowed.

With the passage of the Forest Practices Act, most silvicultural practices are regulated under that law, while road construction is still defined as substantial development and requires a shoreline permit. Considerable confusion still exists over this division of responsibilities, especially since the Forest Practices Act is administered at the State level by the Department of Natural Resources, and the review periods for the respective permits are completely different. Regulations under the Forest Practices Act are still being finalized, but the emphasis in that Act understandably is more on timber production than protection of environment.

Agriculture

Most agricultural practices are also excluded from the uses regulated by the shoreline permit system. The 1975 amendments to the Shoreline Management Act exempted "construction and practices normal or necessary for farming, irrigation and ranching activites, including agricultural service roads and utilities, and construction and maintenance of irrigation structures."

The exemptions did not include feedlots. Feedlots and other livestock confinement areas are still substantial development, require shoreline permit and can be positively regulated by the shoreline programs to assure water quality protection. In most jurisdictions, feedlots are prohibited completely in the shoreline management areas.

Most programs also contain provisions for protecting water quality from runoff and erosion by demanding vegetative buffers between streams and cultivated fields. Ranchers are also encouraged to provide fences between streams and pastures.

Residential Development

Except for the forest and agricultural areas, the single-family home is the most dominant shoreline use. Even in rural and forest areas, river banks are often lined with residences. Residential development often causes water quality problems due to incorrectly located individual sewage disposal sites or runoff from pavement.

However, this important use is also exempt from the substantial development permit requirements. Fortunately, most residences have to obtain local building permits, which do provide means for enforcing the shoreline regulations. Subdivisions, mobile home parks, and multi-family structures all have to obtain shoreline permits and can be controlled directly.

The typical regulations for residential development deal with setbacks from the water and bulk specifications. Developers also have to preserve vegetation and control erosion during construction.

Over-water construction is not permitted, except for houseboats in already established areas and then only with proper sanitation measures. Residences have to be located in suitable places where the necessary services and utilities are available, and where the land itself is stable and physically suitable for development, but not in places like floodways or marshes.

Mining

Another use with potential for causing water problems is mining. (In shoreline areas mining usually means removal of gravel or rock from either the shore or the streambeds.) Mining in Washington is regulated by the Surface Mining Act,[4] but the shoreline programs usually contain specific shoreline-oriented regulations.

Mining in general is discouraged from shorelines, and many local programs prohibit it all together, especially removal of material from the streambeds. When mining is permitted, the operator has to avoid damage to aquatic life and hydraulic processes and also has to assure protection of the scenic quality. It usually means that only controlled amounts of material may be removed from certain less sensitive shorelines.

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4. RCW 47.42

Bulkheads and Landfills

Bulkheads and landfills also have strong impacts on shoreline areas and, for that reason, are strongly discouraged by shoreline programs, especially in undeveloped areas. As a general rule, bulkheads are to be used only to protect property from damage, but not to create additional land at the expense of intruding into a water area.

Simple protective bulkheads associated with single-family homes are also exempt from the permit requirement, provided they are constructed above the high-water line and do not involve a fill. Fills that intrude below the high-water line are generally permitted only for water dependent uses, or for public uses in already developed areas. Marshes and swamps are not to be filled.

Only clean fill materials, which would not cause pollution are permitted. Solid waste is not to be used as fill material. Sanitary landfills within shoreline areas are prohibited.

Dredging

Dredging is mainly to be used to improve navigation and is to be conducted with utmost care to minimize the disturbance. Dredging for the single purpose of obtaining fill material is prohibited.

Disposal of dredge spoil materials is another sensitive issue which requires careful consideration so that the material is deposited either where it is actually needed, or where it will cause the least amount of damage. The deposits have to be secured to avoid erosion and leaching back in the water. Disposal in water is to be limited only for improvement of fish habitats or a public use such as a swimming beach.

Piers

The shoreline programs also discourage proliferation of single-family piers, although construction of such piers under $2,500 again does not require a permit.

Recreation

Water oriented recreation is regarded as a preferred use by the Act, and public access to publicly owned shorelines and waters is to be actively promoted. Besides the obvious kinds of water oriented recreation such as swimming, boating, waterskiing, and fishing, there is also hiking and camping which are enhanced if done near water. And last, but not least, is the simple aesthetic enjoyment of viewing attractive scenery or watching water oriented activities in harbor areas. Most of the recreational uses are nonconsumptive and do not cause pollution, yet they are hard pressed by competition from the other uses. There are also problems in locating public parks and boat launching areas, because, quite often, these are very intensive uses that attract great numbers of people and cars, which can create undesirable impacts on the site and the adjacent areas. So, while recreation is a preferred use, many counties have included stringent regulations in their programs in order to protect water quality and integrity of the shoreline.

Most programs encourage shoreline access by requiring large waterfront developments to provide both physical and visual access. The programs also encourage enhancement of shorelines in already developed areas.

Commercial and Industrial Development

Both commercial and industrial uses are permitted in urban areas with strong preference for shoreline dependent or shoreline oriented uses. Exceptions to the "no overwater development" rule are given only for water dependent uses. Redevelopment of already developed shoreline areas is encouraged. Regulations vary somewhat between jurisdictions but essentially are aimed at locating the uses on physically suitable sites and in minimizing their negative impacts on the environment.

Roads

Roads and railroads are to be located and built in such a way as not to cause problems due to erosion, and to minimize the need to intrude into the streamway area. Cuts and fills within streamways are to be avoided and filling of swamps for road purposes is also to be avoided.

WHAT HAS BEEN ACCOMPLISHED?

Since June of 1971, approximately 3,300 shoreline substantial development permits have been processed. Of these, 220 have been appealed.[5]

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5. About one-half of the appealed projects are resolved before they go to the Shoreline Hearings Board, because a compromise in design is reached through negotiations with the developer.

So much for statistics and procedures. The Shoreline Management Act obviously is alive and functioning as intended. The main question, though, is how well has it implemented the policies voiced by the legislators now that the Act has been in effect for almost five years.

First, let me discuss briefly the methods of enforcement. The Act authorizes prosecution of violators who wilfully violate shoreline permits or evade the permit system. The offenders are subject to fines and imprisonment and may be held liable for restoration. Either the attorney general or the local prosecutor may bring the charges. However, there is a shortage of personnel both at state and local levels to effectively monitor violations. Most violations are brought to the State's attention by private citizens or environmental groups unhappy with what is happening on a nearby shoreline. Also, there is a reluctance at the local level to prosecute violators. As a result, only those projects that proceed through the proper channels and request a permit are reviewed properly. How many unauthorized shoreline projects have been built versus the 3300 legal ones, nobody knows. Hopefully, now that the programs have been completed, more attention will be given to the enforcement.

The numerous exemptions from the permit system are another problem. A single-family home involving a protective bulkhead and a pier for the owner's boat can be built without obtaining a shoreline permit. Yet single-family homes are the most prevalent shoreline use, and often cause modifications to the stream channel and contribute to nonpoint source pollution. Most of the bulkheads on state shorelines are built without a permit, because they fall in this exempt category.

Now, all shoreline development, even when exempt from the permit requirements, is subject to shoreline program policies and regulations. But without the permits, such regulations are difficult to enforce. Residential development at least is usually subject to local buiding permits, which helps enforcement of shoreline regulations at the local level. Other exempt activities, such as agriculture, are more difficult to regulate. There is no assurance whether buffers are left between plowed fields to prevent siltation, or if chemicals are sprayed, or if cattle are permitted to enter a stream. Hopefully, education about the shoreline processes and effects of man's activities will eventually make people realize that sensible shoreline management is for their own benefit.

Now let's try to analyze how well after five years shoreline management is following the objectives and policies formulated in 1971.

How well has shoreline management succeeded in minimizing environmental damage?

It is yet too early to determine the effects of the planning areas, or "environment" designations, which are supposed to provide overall guidelines for what type of activity belongs on what shorelines. The local master programs have not been in effect long enough. On project-by-project basis, though, it can be said that, yes, the negative environmental impacts have been lessened or avoided.

The most prevalent permit denials have been the cases where a nonwater dependent use causes substantial ecological damage to an unmodified shoreline.

Overwater structures have not been constructed, unless they need that location for their function. This has been generally observed also by single-family homes.

Bulkheads for single-family houses have continued, but their intrusion into water areas has been minimized and designs often modified. The massive fills behind bulkheads are now strongly discouraged. Landfills were involved in over half of appeals during the first three years of shoreline management, and the Shoreline Hearings Board often reduced or eliminated fills for non-water dependent commercial projects, and asked that such projects be relocated upland.

Filling of marshes, swamps, and estuaries generally is not allowed. Fill materials are carefully monitored and solid waste is not acceptable for that purpose.

Sanitary landfills and feed lots are not permitted near water bodies.

Important habitats are protected. Development is guided away from sensitive areas, and is being discouraged.

Some shorelines are even pereserved in natural conditions.

Has shoreline management really promoted water dependent and water oriented uses and encouraged other uses to locate away from water's edge?

Nonwater dependent uses have not been prohibited from shorelines, but they are not permitted to intrude over or into water areas. They are not permitted on fills. Some programs contain more stringent provisions than others regarding location of water dependent commercial and industrial uses.

Is there a noticeable increase in public access and recreational opportunities? In the public's ability to enjoy the shorelines?

Public recreational opportunities have not noticeably increased as a result of the Act. This is mainly because, in spite of good intentions, there is no additional money available for the purchase of shorelines, only for their management. Access has been increased mainly in the urbanized areas as part of large developments.

Where the shoreline is privately owned, public access can not be increased, because the Act also stresses protection of individual property rights.

Shoreline aesthetics have been improved. Developments are required to consider design impacts, retain natural vegetation or provide landscaping. Opportunites to view water areas have been increased. The people are more aware that a local stream can be turned into a desirable amenity for a community. Aesthetics is a strong determinant in shoreline project evaluation.

In case of completely new community development, like relocating the Town of North Bonneville, the entire shoreline area has been left as open space. At least it's planned that way.

Probable effects on instream flows

The most obvious effect from shoreline management on instream flows could be the reduced negative environmental impact in its various forms.

More could be done by the shoreline program and the state's water programs to reinforce each other through closer coordination which has not always been the case. Some of the problems are the different jurisdictions for program implementation - political boundaries vs. drainage basins. There are also uncoordinated timetables for the various programs, so that information gained in one program is not always available at the appropriate time for another program.

As I said before, shoreline management is an environmentally oriented land use program and, as such, deals with all types of human activities and their effects on the various aspects of natural environment, including effects on instream flows and water quality.

TOPIC II-F.

LAND-USE PLANNING RELATED TO IFN

Summary Discussion

Land and water use planning are inseparable components of any meaningful effort to guide the development of our land and water resources. Land development patterns can influence water use just as water use policy and programs can shape land use patterns.

Oregon's Land Use Act of 1973 provided the authority for achieving statewide coordinated comprehensive land use plans. One of 14 goals adopted by the State Land Conservation and Development Commission contains language which encourages the protection of instream values and the resolution of conflicts between consumptive and non-consumptive water uses. Oregon's Water Resources Department coordinates by identifying water supply problems and alternative solutions. Determining the carrying capacity of streams will help identify growth potential on adjoining land areas.

The Washington State Shorelines Management Act of 1971 regulates development along streams with an average annual flow in excess of 20 cfs and around lakes larger than 20 acres. The Act directs that development complement natural shoreline values. Further regulated are several instream activities such as mining and dredging or any other activity which could significantly degrade water quality or quantity.

The U.S. Forest Service has developed a land classification technique for mapping sensitive areas along streams. The technique has been used to coordinate land use activities which are compatible with aquatic habitat.

Notes by panel moderator: Rollie F. Rousseau, Oregon Dept. of Fish and Wildlife, Portland, OR

SHORT COURSE III-B.

RIVER HYDRAULICS FOR NON-ENGINEERS

Outline of Discussion

I. Hydraulic Flow Equations

A. Continuity: Matter can be neither created nor destroyed

1. Expressed by the "continuity" equation

$$Q = AV$$

Q = discharge (typical units cubic feet per second)

A = area of flow section (typical units square feet)

V = velocity of flow (typical units feet per second)

2. Note - widespread use of "miner's inch"

B. Energy: Energy can be neither created nor destroyed (but it can be dissipated in friction, turbulences, etc.)

1. The "Manning" Equation is a typical way of expressing this law, for uniform flow

$$Q = \frac{1.49}{n} AR^{2/3}S^{1/2}$$

Q = discharge, as above

A = area, as above

R = A/P where P is the "wetted perimeter" or length of water-solid boundary interface

S = slope or gradient of channel, or fall/length

n = a roughness coefficient

2. Note that $V = \frac{1.49}{n} R^{2/3}S^{1/2}$

3. Velocity distribution, fluctuations, etc.

i - Dependence on "n"

ii - Significance of R and S

II. River Building: The Process of Erosion

A. Increasing velocity leads first to movement of bed particles by rolling or sliding - "bed load" and then to suspension of particles in flow - "suspended load"

B. Criteria for critical conditions, triggering start of erosion

1. Velocity - bed particle diameter, see Figure 1

   i - Note effects of cohesion, etc.

2. Tractive shear-bed particle diameter, see Figure 2

   i - Tractive shear, τ_o

$$\tau_o = \gamma \frac{A}{T} S$$

where γ = specific weight of water (62.4 lb/ft^3)

A = area, as above

T = top width of stream

S = slope, as above

C. Sediment Motion

1. Prediction formulas - none entirely satisfactory or universally applicable, but in general increasing Q increases sediment discharge Qs, see Figure 3

2. Bed Form Development - Ripples, dunes with ripples, dunes, washed-out dunes, plane bed, standing wave, anti-dune, chutes and pools, see Figure 4

3. Regime concepts - Qs, d $\sim$ Q,S

III. <u>River Development</u>

A. Meandering and Braiding

1. Criterion for distinguishing given by

$$S = \frac{0.06}{Q^{0.44}}$$

where Q is the "bankfull" discharge

2. Meander geometry and mean annual discharge, see Figures 5 and 6

B. Meander Progression

1. Sharpening of bends, movement downstream, cutoffs, etc.

IV. <u>River Measurements</u>

A. Discharge of Water

1. Velocity (float or current meter, see Figure 7)

2. Head (weir or flume, see Figure 8)

3. Gaging

   i - Establishment of station

   ii - Recording (see Figures 9 and 10)

B. Discharge of Sediment

1. Suspended load - Sampler (see Figure 11)
2. Bed load - measurement is difficult

V. River Hydraulics as Related to Instream Flow Needs and Problems

A. Man's activities affecting erosion and sedimentation, altering regimes, etc.

1. Withdrawals, channel changes, bridge piers, impoundments, etc.

B. Problems of defining flow conditions needed for given levels of fish support, wildlife habitat, etc.

DISCUSSION

There was a considerable amount of discussion and questions regarding the erosion of streams and channel improvements proposed by the Corps of Engineers.

1. A number of people from Oregon were very much concerned by Corps plans to channelize large stretches of the Willamette River. They fear this will lead to additional channelization, and eventual complete loss of fish and wildlife habitat in the entire river. They asked about consequences of gravel removal from the riverbed; likelihood that bank protection will lead to increased bed scour; and use of Mannings equation to design the slope of culverts.
2. The most discussion centered around examples of sediment discharge-water discharge relation, e.g., release of clear water from a dam at controlled rate (instead of natural periodic flooding) causing increased downstream erosion; diversion of water from streams causing deposition because the sediment-water function is exponential; increased erosion from additional water being added to the stream for the same reason.

Short Course by: Theodore T. Williams
Professor and Head
Dept. of Civil Engineering and
Engineering Mechanics
Montana State University
Bozeman, MT 59715

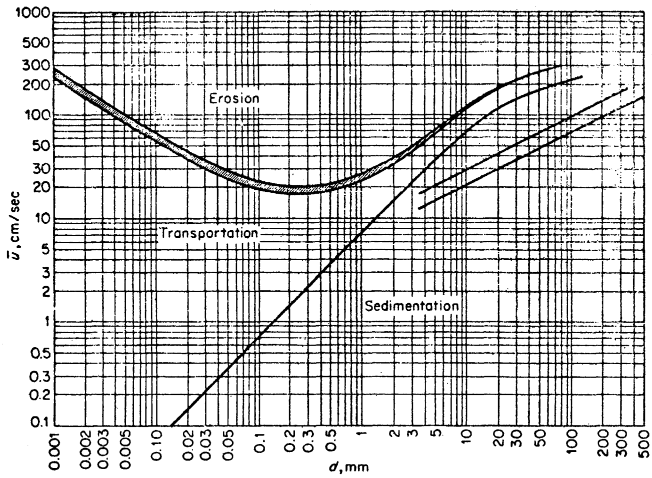


Fig. 1. Erosion-deposition criteria for uniform particles (After Hjulström, 1935)

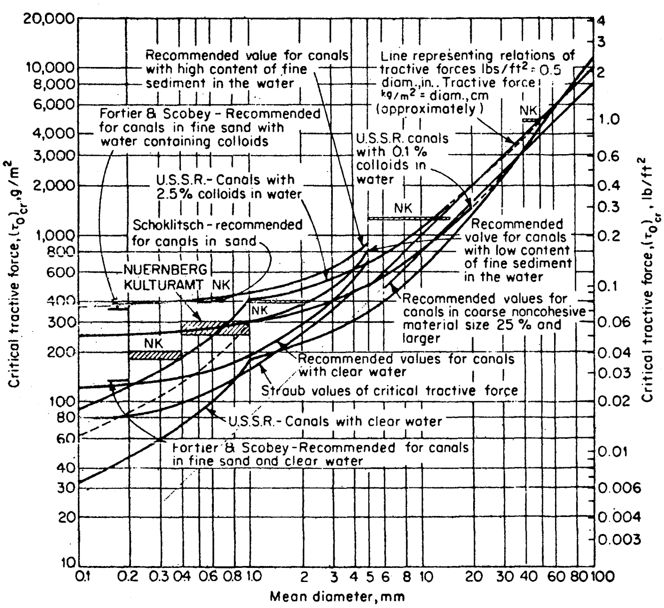


Fig. 2. Critical shear stress as function of grain diameter (After Lane, 1953)

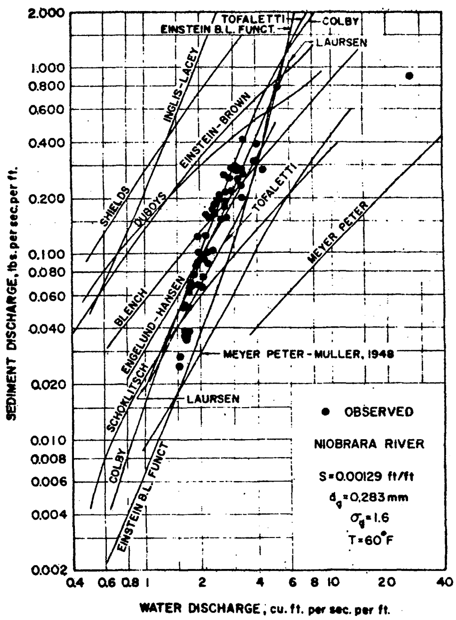


Fig. 3. Sediment discharge as function of water discharge for Niobrara River near Cody, Neb., obtained from observations and calculations by several formulas

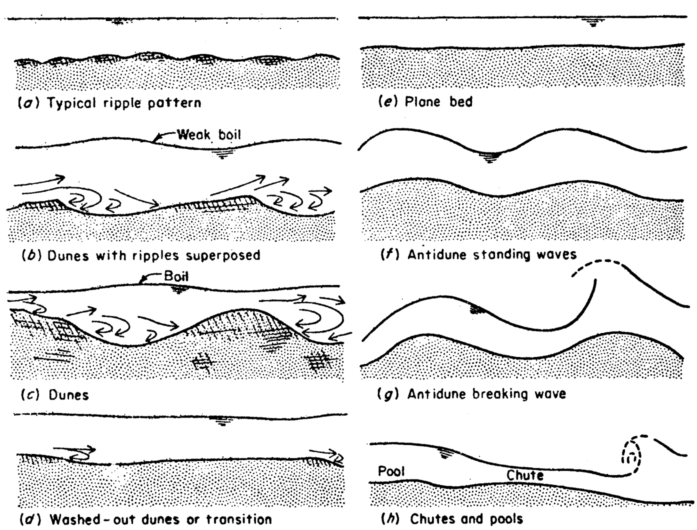


Fig. 4. Idealized bedforms in alluvial channels (After Simons et al., 1961)

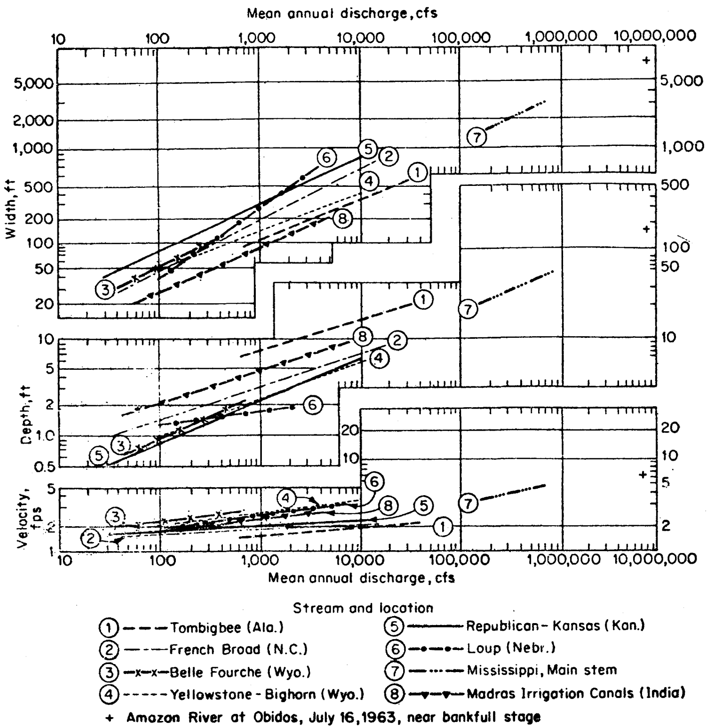


Fig. 5. Width, depth, and velocity vs. mean annual discharge, with the discharge increasing in downstream direction for various rivers (After Leopold et al., 1953)

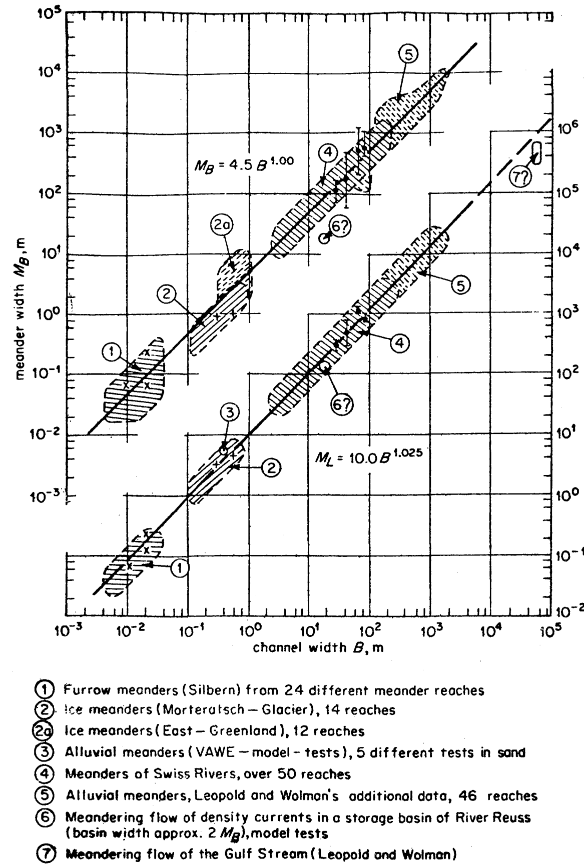


Fig. 6. Empirical relation for the geometry of meanders (After Zeller, 1967a)

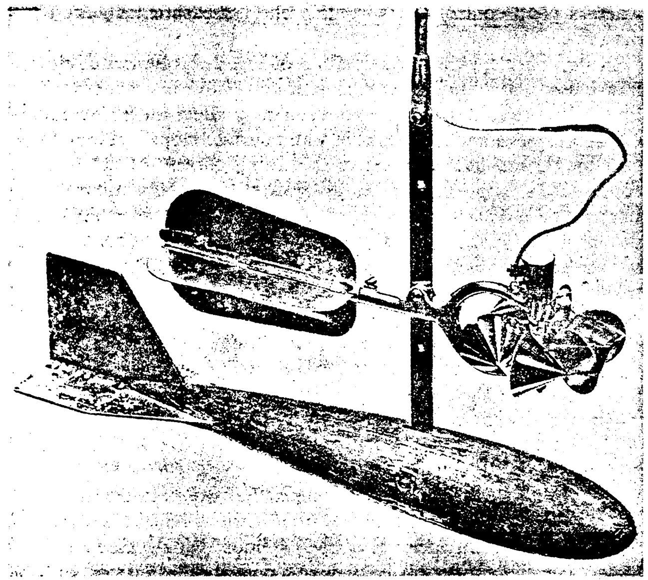


Fig. 7. Price current meter and 30-lb C-type sounding weight (U.S. Geological Survey)

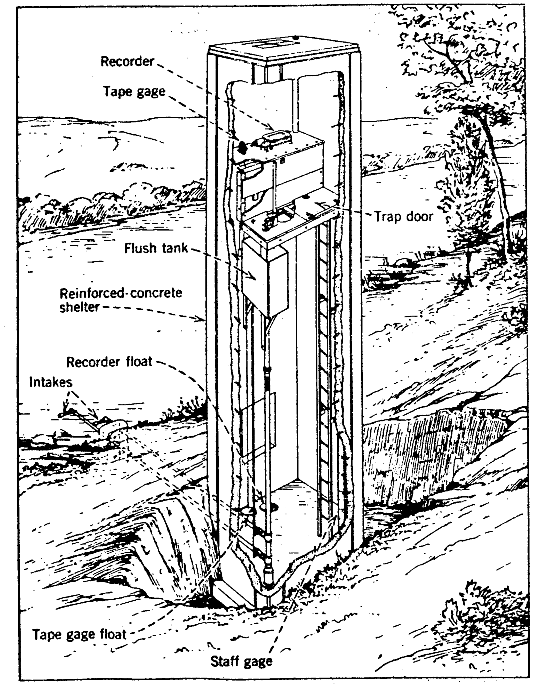


Fig. 9. Typical water-stage recorder installation (U.S. Geological Survey)

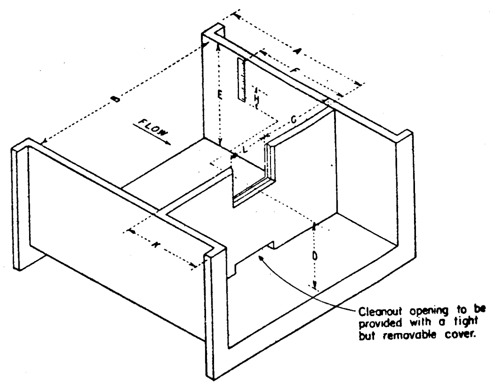


Fig. 8. Weir box (103-D-860)

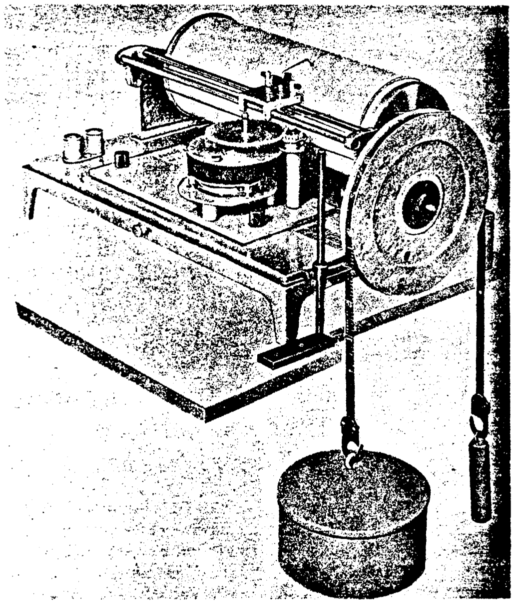


Fig. 10. Horizontal drum water-stage recorder. The time element records parallel to the axis of the drum. PX-D-53977. (Courtesy Leupold and Stevens Instruments, Inc.)

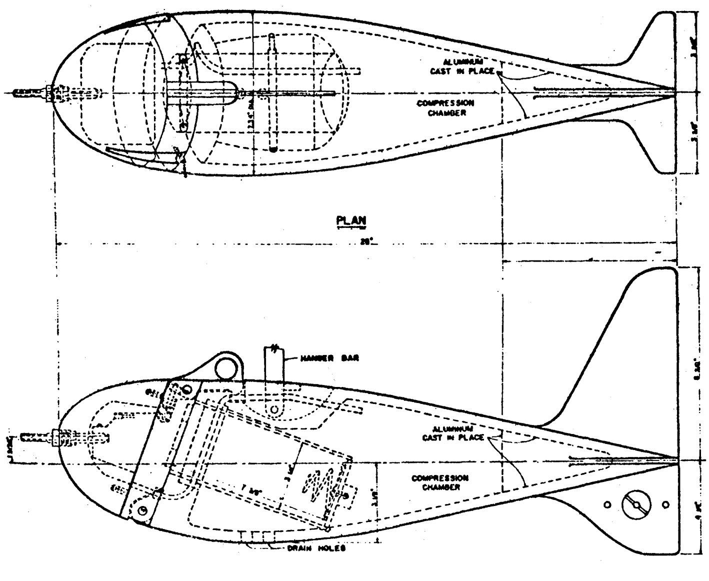


Fig. 11. US P-61 Point-integrating suspended-sediment sampler (Interagency Committee, 1963)

SHORT COURSE III-C.

GENERAL HYDROLOGY

Outline of Discussion

Introduction
1. Competition for waters
2. Variability of supply
3. Role of hydrology

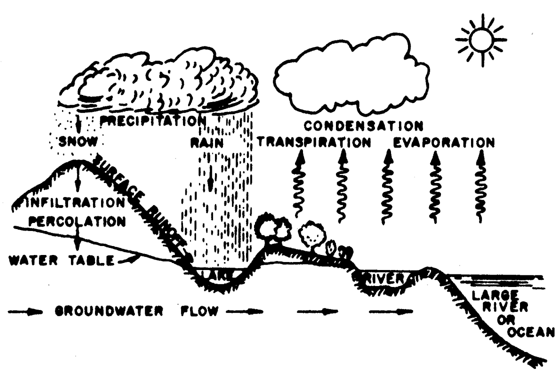
Hydrologic Cycle
1. Important processes
2. Precipitation-runoff relationship

Low Flows
1. Demand vs. supply
2. Hydrologic limitations

Data Sources
1. Typical USGS discharge record
2. Data availability

Low Flow Analysis
1. Flow duration curves
2. Frequency studies

HYDROLOGIC CYCLE



Short Course by: Richard L. Brustkern
Dept. of Civil Engineering and
Engineering Mechanics
Montana State University
Bozeman, MT 59715

SHORT COURSE III-D.

LOW FLOW CHARACTERISTICS

Outline of Discussion

Purpose: To illustrate the potential of various streamflow indices for establishing Instream Flow Needs. The utility, derivation, accuracy, and limitations of each index is discussed. Shown as an example are the results of recent work that relates fish spawning and rearing potential to streamflow characteristics.

Temporal Variability of Streamflow

Statistical parameters
Recession curves
Duration curves
Frequency curves

Flow Augmentation by Storage

Areal Variability

Estimates from limited flow data
Estimates for ungaged sites

Regulated Flows

Characteristic changes
Stream-system models

Flow Characteristics Desirable for Fish Spawning and Rearing

Criteria
Characteristics evaluation
Effects of flow changes

Short Course by: D. M. Thomas
U.S. Geological Survey
Reston, VA 22092

SHORT COURSE III-E.

BIOLOGICAL CONSIDERATIONS AND HYDRAULIC STRUCTURES

Outline of Discussion

INTRODUCTION

A. Instream flows are tied to hydraulic structures in rivers by various factors

   1. Alteration of stream flow at the structure itself--includes construction aspects

   2. Altered flows downstream of structure

   3. Altered flows upstream of structure

   4. Possible altered flows in another stream (e.g., return irrigation water or cross drainage water diversion)

B. Structures include primarily dams, weirs and diversion structures with main emphasis on dams

C. Dams and reservoirs

   1. Types of dams--irrigation, power, flood control, industrial, navigation, municipal, fish and wildlife, recreation

   2. Type of dam and purpose has an impact on biological systems both in the reservoir and downstream

   3. Factors which affect biological development in a reservoir include:

      a. water quality in drainage
      b. climatic conditions
      c. exchange rate
      d. density currents
      e. stratification and water depth
      f. man's manipulation

   4. Complex interlinked process between physical conditions of a reservoir and final biological production

      a. species in basin adaptable to reservoir situation
      b. flooding new land and effects on water quality and in turn biological productivity
      c. most reservoir systems still primative as far as evolution of biological productivity is concerned--how long some reservoirs will remain good fish producers is still a guess
      d. considerable work done on reservoir productivity and the various reservoir fisheries

D. Biological considerations downstream of dams or diversions

   1. Commonly used terms include "minimum streamflow," "fishery flows," "survival flows," "base flow"

   2. NEPA and the advent of the E.I.S. required water resource development agencies to assess impacts of their projects on the biological communities, i.e., the environment

3. The biological community is tied to the type of dam and release; therefore the important chemical and physical aspects of the release water are:

    a. flow volume
    b. temperature
    c. various chemical aspects of the water
    d. fluctuations and man's manipulations
    e. special problem factors such as dissolved gas, etc.

4. What most biologists can do now is to:

    a. assess the aquatic biological situation prior to a project
    b. predict what the impacts of the project will be on the aquatic situation
    c. make recommendations for minimizing the impacts and/or improving the aquatic biological situation

D. Assess biological situation prior to project

1. Requires lead time to survey and inventory stream

E. Predict what the impacts of the project will be on the aquatic situation

1. Involves predicting biological productivity under various controlled conditions

2. When planning a project, the biologist is asked:

    a. what species of fish will do the best in reservoir and tailwater areas
    b. what will be the productivity or growth of the fish
    c. what will be the stocking rate or natural reproduction
    d. what will be the fisherman use
    e. what will be the fisherman catch

3. How little water can a fishery take and still remain a viable fishery

4. So all we do is look at our crystal ball and whip out all these answers so the planners can plug costs into the cost-benefit and assess impacts. IT IS NOT THAT SIMPLE!!

5. Flows and water temperature are the most important factors

    a. Flows--various techniques to determine flows
    b. Shapes of hydrographs--flow figure is placed in the water supply picture to see if the recommended flows are compatible with the overall project (not always the case)

        (1) tie flows and supply to the management species life history; Rainbow, Brown, bass, tilapia
        (2) tie to nuisance species drop level to get rid of carp and trash fish reproduction
        (3) tie to management; catchable program with no reproduction reduce flow in nonfishing period
        (4) constant flow versus cyclic flow may depend on species
        (5) climate and factors as anchor ice may require adjustment in flow
        (6) fisherman use and flows requires access

c. Stream Temperature

(1) depends on climate
(2) depends on size of reservoir and design
(3) depends on density currents and internal flows of reservoirs (stratification)
(4) can control location of outlets
(5) predict downstream temperatures using computer modeling; (getting more proficient)--reservoir model permits prediction of how the reservoir will stratify--based on a design, downstream temperatures can be predicted

d. Species of fish which will do well and an idea of stream productivity can be predicted based on flows and temperatures. Fisherman use is a tough parameter to predict based on existing pressure, population centers, and accessibility figures. If waters produce exceptional fishing, all the predictions are voided. Sportsmen influence the species of fish (e.g., Colorado is rainbow trout; country and its species is usually considered first).

PROBLEMS

1. temperature
2. gas saturation
3. flow fluctuation
4. too much biological productivity
5. turbine mortality
6. spilling
7. new artificial situation favors undesirable species
8. access
9. fish screens and weirs on outlet works
10. others

EXAMPLES OF SOME OF THE PROBLEMS AND SOLUTIONS

Hydraulic structures and flow:

1. Taylor Park flows (now 1 species)
2. Clark Canyon flows (2 species)
3. Flaming Gorge flows (recreation and fish)

PICTURES

1. Flaming Gorge penstocks slide series
2. Clark Canyon slide series
3. Navajo gas problems
4. Silver Jack gas and flow problems
5. Kafue River

SUMMARY

The course was taught by referring to examples of structures (primarily dams) which were already in operation. Prime examples of biological (fishery) considerations and problems which were occurring above, below, and at the structure were noted. Examples used for the part on non-anadromous fish included:

1. Flaming Gorge Dam on the Green River;
2. Navajo Dam on the San Juan River;
3. Curecanti Unit of three dams on the Gunnison River;
4. Taylor Park Dam on the Taylor River;
5. Clark Canyon Dam on the Beaverhead;
6. Gunnison Diversion Structure on the Gunnison River;
7. Barrett's Diversion Structure on the Beaverhead; and
8. Various temporary irrigation diversion structures.

Anadromous fish examples were on the Columbia River System. Emphasis was on the lower Columbia dams and Snake River dams.

Biological contrasts were emphasized between the various structures. Flow regulation and water temperature were two of the more important biological considerations pointed out at the various structures. In the Columbia River system the gas saturation and flow problems were emphasized from a salmon and steelhead viewpoint. Downstream juvenile migrant passage problems were discussed in terms of past and future consideration for solving some of the problems. Revolving screens, by-passes, regulated spills and trucking of juvenile downstream migrants were discussed.

Mortalities of young and juvenile salmon and steelhead with regard to turbine mortality and gas saturation were presented as well as the effects of fish ladders and flow regulation on adult salmon and steelhead survival and reproduction.

New topics covered included pump storage and the potential biological problems associated with these operations.

Short Course by: William Miller
Natural Resource Specialist
U.S. Bureau of Reclamation
Grand Junction, CO

Assisted by: Terry Holubetz
Environmental Services Coordinator
Idaho Dept. of Fish and Game
Boise, ID

SHORT COURSE III-F.

QUANTIFYING FISHERIES HABITAT

Discussion

J. C. Fraser: In determining instream flow needs of fish we are generally emerging from a period of guesswork or the application of "rules of thumb" into a period of quantifying the needs of fish or the other components of the aquatic biota in terms of specific flows for various parts of their life cycles.

This session is intended to bring forth for our review and discussion some of the techniques being used to quantify the habitat flow needs. Many measurements of fish habitat characteristics are being made and quantities of data are accumulating. Hopefully we will constantly seek the true relationship between physical data and the biological needs of the stream environment.

Thomas A. Wesche: "A Trout Cover Rating System and Its Application to IFN Determinations"--In making instream flow recommendations, the biologist or hydrologist faces the problem of "quantifying the habitat gains and losses occurring at various discharge levels. One important parameter under the general area of trout habitat is the availability of cover and resting areas. For several years, the Wyoming Water Resources Research Institute has been active in defining trout cover criteria and developing a system for quantifying cover and testing the ability of this system to estimate the trout carrying capacities of various stream sections under varying flows.

The first step is to establish some criteria for a stream habitat factor to be measured. Then a rating system must be developed.

Electro fishing was used to locate where trout were holding in a stream. Wherever trout were located, depth and velocity measurements as well as cover type were recorded.

A rating system for cover was then developed based on the following formula:

$$\frac{L_{UCB}}{T}(PF_{UCB}) + \frac{A}{SA}(PFA) = CR$$

where: L_{UCB} = length of undercut banks;
T = Thalweg length;
PF_{UCB} = preference factor for undercut banks;
SA = total surface area at average daily flow;
A = area with water depth $\geq$ 0.5 ft and substrate > 3-in. diameter;
PFA = preference factor for rubble-boulder areas.

Brian Waters: "Investigational Techniques for Relating Changes in Streamflow to Changes in Fish Habitat"--By the mid-1960's there was still little standardization of methodology for recommending appropriate streamflows below impoundments. Those of us working on the subject recognized that professional stream resource biologists and managers should place the emphasis of their flow analysis work on determining the quantitative relationships between streamflows and various habitat parameters.

A change in flow results in a change in the physical characteristics of all microhabitats of all fish species present, their predators, their competitors, and the food organisms down through the food chain upon which they depend. For each organism category, at different life history stages, there are microhabitat requirements for upstream and downstream passage, reproduction, egg and larvae rearing, resting, feeding, and cover. Each microhabitat requirement can be defined by water depth, water velocity, and bottom substrate. Hence we have the basis for a model.

Preliminary Planning and Field Work Preparation

Representatives of all organizations cooperating in the study meet to agree on which section(s) of stream will be studied, which release flows will be studied, how release flows will be verified, when the study will occur, the number and locations of stations and transects, the spacing of measuring points along each transect, the identity of individual field workers, the location of photographic stations, and other related matters. It is agreed that each cooperating organization will receive a copy of all original field data sheets with which to do anything it wishes, independently of an agreement to share results of the analysis resulting from the computer program described later in this paper.

On some streams a preliminary field review is undertaken to observe typical sections under several flows. These observations, possibly documented by photography, may then be used as a basis for selecting study stations and release flows.

If more than one crew of workers will be involved in data collection, an attempt is made during the planning phase to balance the capabilities of each crew after considering such factors as employer organization, experience on studies of this type, logistic support (if it covers a large geographic area), and which days people are available. For continuity, it is desirable to have the same personnel available for all days of the study. In particular, if cover is included as a study parameter it is imperative that the same worker does the subjective evaluation each day.

The number of stations per stream section, the number of transects per station, and the distance between measuring points along each transect will depend on the variability in stream types (cascades, runs, riffles, pools) and mean stream width. Based on past experience with stream habitat variability and practical logistics problems, around 600 measuring points per stream section are generally selected. A three-person crew with one meter should be able to collect at least 300 point measurements per day, and a five or six-person crew with two meters should be able to collect at least 600 point measurements per day.

Station locations are selected to be representative of the stream section in question. Major pool areas are avoided because they are not habitats where significant ecological changes occur with changes in flow. However, if resting habitat is likely to be a limiting factor, slow water areas may be given special consideration. Ease of access is a consideration in station location selection only when the representativeness of the final locations selected is assured. If uncontrolled accretion is significant in a stream section, stations should be spaced to include the range of accretion flow conditions that exist.

After station locations and the number of transects per station have been determined, the ends of transects are identified with stakes firmly installed above the water line of the highest flow studied. The distance between transects (commonly 20 to 50 feet) depends mostly on the length of stream available at the station. Stakes are located on one side of the stream by measuring the fixed pre-determined interval along the streambank. Stake locations for the ends of the transects on the opposite streambank are selected by eye such that the transect is perpendicular to the flow at that point in the stream, even if this results in adjacent transects not being parallel.

Table 1. Number of measuring points resulting from various combinations of stream width, measurement interval along transects, and total number of transects. Transects are divided evenly between stations, usually 2 or 3.

If mean stream width at highest test flow is (ft):	And measurements are taken at intervals of (ft):	At a total number of transects of:	The number of measuring points will be:
0- 15	0.5	18	0-540
16- 20	0.5	12	380-480
21- 30	1.0	18	380-540
31- 40	1.0	12	360-480
41- 50	2.0	18	370-450
51- 75	2.0	15	380-560
76-100	4.0	18	340-450
101-150	5.0	15	300-450
151-200	5.0	12	360-480
201-300	10.0	15	300-450

Field Data Collection

Prior to the initiation of field measurements, all participants should meet to review individual responsibilities, resolve any questions, stress the importance of a standard systematic approach to all aspects of the field study, and inventory equipment and review its use. An example of the field data recording form is given in Table 2, and the general instructions for using it are given in Table 3.

Table 2. Example of streamflow evaluation field data recording form.

PLEASE PRINT CLEARLY

Page____ of____

Stream	Sta No.	Tr. No.	Depth of Meas.	Date Mo	Date Day	Date Yr	Time
1 2 3 4 5 6 7 8 9 10 11 12	13 14	15 16	17 18 . 19	20 21	22 23	24 25	26 27 28 29

Water Temp. °F	Test Flow	Meter No.	Measured by	Recorded by
30 31 . 32 33	34 35 36 . 37 38	39 40 41 42 43 44 45	46 47 48 49 50 51 52	53 54 55 56 57 58 59

Notes:

Distance on Transect	Btm Code	Cvr. Code	Depth in feet	Revo-lutions	Time in Seconds
60 61 62 63 . 64	65 66	67 68	69 70 . 71 72	73 74 75	76 77 78 79 . 80

Distance on Transect	Btm. Code	Cvr. Code	Depth in feet	Revo-lutions	Time in Seconds
60 61 62 63 . 64	65 66	67 68	69 70 . 71 72	73 74 75	76 77 78 79 . 80

Bottom Type Code:
1 Plant Detritis
2 Clay
3 Silt
4 Sand
5 Gravel (⅛"-3")
6 Rubble (3"-12")
7 Boulder (>12")
8 Bedrock
9 Other

Subjective Cover Code:
1 No Cover
2 Fair Cover
3 Good Cover

PLEASE PRINT CLEARLY

Upon arriving at a transect, crew members stretch the tape tightly between the two stakes. At this point, it is especially important to have the zero end of the tape exactly over the base of the stake. The zero has to be at the same place for each study flow. The zero end of the tape is always on the study access side of the stream.

The highest flow to be studied is released first, immediately confirming that transect stakes have been placed appropriately in relation to water elevation. Flow are allowed to stabilize before any measurements are made. Usually this is done by having only one study flow per day, with releases set late in

Table 3. Instructions for filling out streamflow evaluation data recording form.

Note: Always print clearly with medium soft pencil (No. 2 or 2-1/2)

Columns	Recorded Information
1-12	Name of stream. Be as specific as possible as to location. Use AB=Above, BL=Below. Use abbreviations when necessary (e.g., NFKINGSABWIS = North Fork Kings River above Wishon).
13-14	Station number in the section of stream being tested, 1-99.
15-16	Transect number at the station, 1-99.
17-19	Depth of measurement. Usually held constant at 0.2 feet.
20-25	Date. Use normal sequence of month, day, year.
26-29	Time. Military time approximately half way through transect.
30-33	Water temperature in °F to nearest 0.1° if taken.
34-38	Test flow in cfs to nearest 0.1 cfs. This is the release flow that exists at the time of the study. Do not record intended test flow. Record only after actual release flow is verified.
39-45	Meter No. (right adjusted). If more than seven alpha-numeric characters long, use last seven.
46-52	Measured By (left adjusted). Name of person who does all or majority of metering. Use sequence of first initial, second initial, last name. If more than five letters in last name, record only the first five.
53-59	Recorded By (left adjusted). Same instructions as Measured By.
60-64	Distance on Transect. The point along the tape in feet where the measurement is taken. Skip all dry areas that occur at the first (highest) flow.
65-66	Bottom code (right adjusted) using the key at the bottom of the recording form. This only has to be recorded once, and is done at the lowest test flow for convenience in evaluating substrate type. It has to be recorded for all points at which any measurements are taken on any day of the study, even if that point is dry on the day it is recorded.
67-68	Subjective cover code (right adjusted) using the key at the bottom of the recording form. Recorded only if this option is to be included in the study.
69-72	Total water depth to nearest 0.1 feet at point of measurement. If substrate is dry at the point on that day, record as 0.
73-75	The number of complete revolutions counted after the revolution noted when the stopwatch is started. Flow meter is set at depth indicated in Columns 17-19. Epic counter may be used.
76-80	Elapsed time to the nearest 0.1 second (minimum of 30 seconds) from when stopwatch started until it is stopped at a completed revolution of the flow meter. Record as 30 seconds if no depth or too shallow to get a velocity (revolutions) reading. Epic counter may be used.

afternoon of the previous day. On uncontrolled streams, study participants must attempt to obtain differing flows as they occur naturally, even if this requires long time periods between field study days.

Velocity measurements for our salmonid stream studies are taken at 0.2 ft above the substrate. The data analysis takes this into account to the extent possible.

Each day of the study, photographs are taken in a standardized fashion at each station. The photographs are scheduled to be taken as close to mid-day as possible, allowing for travel time between stations, and at as close to the same time of the day at each of the stations each day so that lighting and shade conditions are comparable. Usually three photographs are taken at each station each day: one directed upstream; one directed across the stream; and one directed downstream. The station number, date, and intended release flow are recorded on a slate placed within view of each photograph for ease of identification.

The relative values for each measuring point for each parameter at each flow are determined by assigning weighting factors (coefficients in the model) to the individual water velocity, bottom substrate, and depth values, and then multiplying them together to get a single composite relative value. Weighting factors can be varied as a function of the species of fish of concern in the stream, its life history stage, and those of its principal food organisms.

Interpretation of Results

The plotted results should not in themselves be construed as making recommendations for a streamflow release regime. Rather, they represent relationships that have been determined in as quantitative and least subjective manner as possible. They also depict relationships which all interested parties can agree to as representing the best judgment of professional fisheries biologists, prior to any interdisplinary evaluation of their application to the final resolution of the release flow regime under consideration. This leaves flexibility for interpretation and consideration of management alternatives based on all relevant factors, including fisheries management needs, comparisons with natural unimpaired flows, water rights, economics, conflicting recreational uses, safety, esthetics, and other interdisciplinary interests.

Thomas Nickelson: "Evaluation of Stream Habitat for Coho Salmon"

INTRODUCTION

The Research Section of the Oregon Department of Fish and Wildlife is currently conducting research with the goal of developing techniques that can be used in natural streams to estimate the influence of stream discharge on salmonid carrying capacity. The rating system for coho salmon habitat to be discussed is a result of this research.

HABITAT RATING SYSTEM

Individual observations made on cross-sectional transects in a given selection of stream are given a "Habitat Index" value based on the following:

			Value
Water Type			
Prime	Depth >30 cm	Velocity <30 cm/sec	2
Marginal	Depth ≤ 30 cm	Velocity <30 cm/sec	1
Cover Type			
Undercut Banks and Submerged Roots			2
Overhanging Cover and Submerged Logs and Limbs			1
No Cover			0
Substrate Cover			
Cobble			2
Gravel			1
Sand, Silt or Clay			0

HABITAT INDEX = Water type value + Cover Value + Substrate Value

The habitat of a section of stream is evaluated on the basis of the individual observations.

Let HI be the habitat index value, which has a possible range of 1 to 6.

N be a species specific constant which reflects the degree of preference of a given species for cover (i.e. for coho N = 1).

OB_{HI} be the number of observations having a value of HI.

TOB be the total number of observations taken in the particular section of the stream in question.

Then, the habitat quality (HQU) for the section of stream is calculated from the equation:

$$HQU = \sum_{HI=N}^{6} (HI-N) \frac{(OB_{HI})}{TOB}$$

This system of evaluating habitat explained 72% of the variation in coho salmon biomass in study sections of the Elk Creek research site. A sample calculation appears in Table 1.

Table 1. Calculation of the habitat quality (HQU) for coho salmon of experimental section 1 at a flow of 5.1 m^3/sec. For coho the value of N is 1.

HI	HI-N	OB_{HI}	$\frac{OB_{HI}}{TOB}$	$(HI-N) \frac{(OB_{HI})}{TOB}$
6	5	0	0.000	0.000
5	4	5	0.016	0.064
4	3	10	0.032	0.096
3	2	40	0.128	0.256
2	1	174	0.558	0.558
1	0	20	0.064	0.000
0		63		
	TOB =	312		HQU = 0.974

STREAM HABITAT AND REDUCED FLOWS

Henry P. Chrostowski
U.S. Forest Service
Uinta National Forest
Provo, Utah 84601

ABSTRACT

A combination of hydraulic geometry and selected habitat characteristics were evaluated to determine recommended winter flow releases in streams which will be impacted by water diversions associated with the Central Utah Project.

Physical aquatic measurements were obtained from a series of cross-sectional transects along stream courses. Measured characteristics included pool-riffle periodicity, pool quality and location, streambottom composition, and streamside environment. Cross-sectional channel profiles were measured at low base flows in conjunction with habitat data. Volume, velocity, and water gradient constitute the index discharge-habitat characteristics.

Hydraulic geometry using Manning's formula were used to compute discharges, velocities, and friction factors at various reduced flow levels. Losses in habitat features for water surface, wetted perimeter, and average depth were computed. Comparison of recommended discharge releases were compared with U.S.G.S. water records and flow duration curves. Discharges can also be computed above the index discharge level.

Recommended releases based on physical characteristics do not relate to biological impacts on stream systems. An assumption is made that adequate velocities, surface areas and depth that approach life cycle requirements for fish passage, spawning, and rearing are valid discharge flows.

The methodology is applicable to small and medium sized streams. Its application on wide, deep river systems is probably not practical. The methodology has not been evaluated under controlled conditions over time.

INTRODUCTION

The necessity to develop a methodology to determine the impact of reduced stream flows on the aquatic habitat was directly associated with development of the Central Utah Water Project. This major multipurpose water resource program is the largest participating segment of the Colorado River Storage Project and is considered the most important future water resource development in the State. A simplified explanation of this extremely complicated program entails the construction of dams, reservoirs, pipelines, aqueducts, canals, diversion dams, pumping plants, dikes, power plants, and trans-basin exchanges of water. Through compacts with other Colorado River Basin states, Utah's annual entitlement to the Colorado River is approximately 1.5 million acre-feet of water. Sixty percent of Utah's contribution to the Colorado River Drainage System is produced in the Uinta mountains located in the north central and eastern portion of the State.

Central Utah Project waters will be obtained from this area for trans-basin export into the Great Salt Lake Basin and the populous Wasatch Front for culinary, agricultural, and industrial purposes. Some water will also be utilized in a few southern counties of the State. As presently planned, the proposed six units of the project will divert water from the eastern portion of the Uintah Basin, intercepting all major streams on the south face of the Uinta mountains westward to Strawberry River. Much of this activity will occur on public lands administered by the U. S. Forest Service.

The Forest Service, in cooperation with the Bureau of Reclamation, U. S. Fish and Wildlife Service, and the Utah Division of Wildlife Resources, conducted surveys on all streams that would be impacted by the various units of the project. The survey period extended from the fall of 1962 to 1970.

Purpose and Approach

The purpose of the stream habitat surveys and water discharge studies by the Forest Service was to determine the flows necessary to retain a sufficient portion of the aquatic habitat in streams which would be affected upon completion of the various units of the Central Utah Project. Little information on methodologies was available in existing literature at the time the surveys were initiated.

Forest Service concerns were associated with the intent and purposes stated in the Multiple Use and Sustained Yield Act, Public Law 86-517 (74 Stat. 215) "...It is the policy of the Congress that the National Forests are established and shall be administered for outdoor recreation, range, timber, watershed and wildlife, and fish purposes..." The question of beneficial versus non-consumptive water uses is a complex legal problem in most western states. Whether stream releases for recreation, fishing values, and retention of aquatic habitat is recognized will depend on future water law decision.

The Central Utah Project is dependent upon the collection and storage of unappropriated winter and high spring flows in streams along the south and west face of the Uinta mountains. The natural low flows in these streams during the winter and nonirrigation months are also critical to the preservation of the aquatic habitat and carrying capacity for fish survival. Appropriated irrigation flows during the summer and fall months generally will be bypassed for downstream water uses. It was apparent that winter releases below diversion points would cause the greatest impact and be the primary objective for retention of sufficient flows to sustain the aquatic habitat for overwintering of indigenous fish populations. Two important considerations had to be evaluated. These included the aquatic habitat and the characteristics of winter flows below diversion points. Recommended release flows would be meaningless unless based upon knowledgeable habitat features and the gains or losses throughout the stream channel.

Habitat Determination

The term "habitat" is a general descriptive word which encompasses many variables. It is generally adaptable to the intent and interpretation of the investigator. We considered it to include those physical elements of the aquatic system that provide food, shelter, and reproductive capability for a viable fishery. Physical habitat varies from stream to stream and throughout the course of any given stream. Natural physical habitat characteristics are influenced by fluctuating levels of flow at given periods throughout the year, weather, normal low flows, temperature, velocity, slope, geological features, and other factors.

The aquatic habitat inventory procedure used on streams which will be affected by the Central Utah Project is patterened after the method described by Herrington and Dunham.[1] This is a stream sampling technique which emphasizes evaluation of the physical features within a water course for their potential as aquatic habitat. It consists of taking measurements along selected transects or line intercepts across streams. Characteristics measured included channel width, water surface width, depth, pools and riffles, streambottom composition, bank stability, streamside vegetation, and water surface gradient. The presence or absence of aquatic vegetation was also recorded. The physical features of each sample were rated on a percentage basis for four selected categories.

Pool measure. A rating of the total sample width as pool and riffle habitat. A pool-riffle ratio.

Pool structure. A rating of the percent of total pool width contained in pools of good quality. A ratio based on pools graded by depth, length, and width in relation to channel width. Pool locations and features were also recorded.

Streambottom composition. A rating of total sample width containing boulder, rubble, gravel, silt, or debris. A gravel-rubble ratio.

Streamside environment. A rating of the streambank vegetative cover in descending order of trees, brush, grass, and exposed banks. A bank cover ratio.

The ratings from the four categories were summed and then divided by the maximum sum possible (400) to obtain the sample rating identified as the habitat "percent of optimum." This rating is indicative of the physical habitat quality of the particular sample and of the stream as a whole when all stations are summed together. The term "optimum" is assumed to reflect ideal conditions if each parameter were a balanced percent factor.

A detailed appraisal of the selected physical habitat features associated with existing discharge flows was necessary to determine reasonable minimum flows which would provide for water in the channel and still retain a degree of desirable habitat features.

Channel Cross Sectioning

Permanent channel cross sections were established to obtain a stream channel profile in relation to the base flow at the time of the survey. Discharge measurements were taken in October or November when water flows are relatively low and access was still available to the streams. The permanent discharge stations were established at selected sites for annual measurements and comparison of flows from year to year. Documentation of gains or losses throughout the stream course are important data when related back to recommended releases below diversion points.

Field Procedures

Aerial photos and 2-inches-to the mile scale maps were used to locate sample stations in the field. Sample points were located at 1-mile intervals beginning at the Forest boundary up to and including the location of the project feature. Each sample station was located as precisely as possible utilizing the aerial photos and scale maps as reference points. As each station was located, habitat collection would begin at a point 50 feet upstream from the sample point. The sample section originally comprised 10 transects per station at 50-foot intervals. This was later reduced to five transects at 50-foot intervals along the baseline of the stream for a total distance of 250 feet from the initial cross-channel station. Habitat features at each station were determined by stretching a tape across the stream channel at a right angle to the control bank.

The channel profile is the configuration which extends between the high water mark at each bank. A visual representation of the channel cross section is then plotted on graph paper for analysis at different water stages below the base measured flow. (See Figure 1.)

Hydraulic geometry features at each water level were computed for the selected parameters of water surface, wetted perimeter, and area with a planimeter. Calculations for velocity, discharge, and friction index (N) were computed for each water stage utilizing Manning's formula to solve for friction index (N) and velocity (V). The base flow velocity is determined from the measured discharge. Knowing the base flow velocity and gradient, the friction index is then computed. The procedure is followed to determine discharge at each successive drawdown level.

$$n = \frac{1.486}{V} R^{2/3} S^{1/2} \quad (1)$$

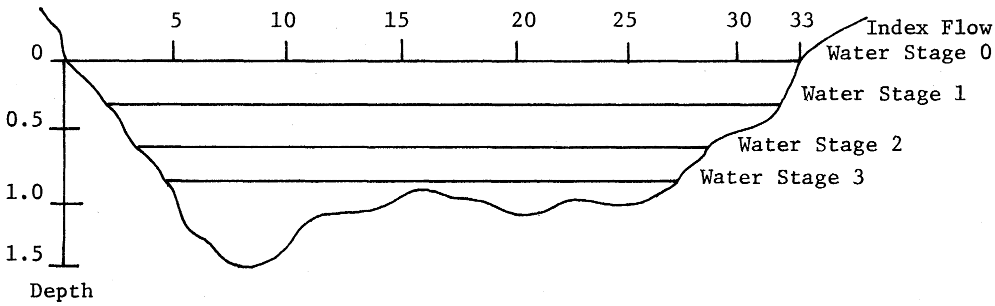
$$V = \frac{1.486}{n} R^{2/3} S^{1/2} \quad (2)$$

$$Q = AV \quad (3)$$

where V = velocity of flow
n = coefficient of friction of flow
$R = \frac{A}{P}$ where A = wetted area and P = wetted perimeter
Q = discharge in c.f.s.

A graph was then prepared for each representative cross section indicating plotted points of the hydraulic features as each water reduction level for the selected habitat values. The field measured values for water surface, wetted perimeter, and average depth influence aquatic habitat components, particularly pool-riffle and pool quality features. The habitat components are indicated as 100 percent values at the upper left margin of the graphic illustration, indicating the habitat trend-discharge relationship at measured low flows. (See Figure 2.)

The relationship of habitat components to discharge when data points are compared is expressed in either a linear or curvilinear form. Analysis of habitat data indicated that in curvilinear form, sharp breaks on the trend line are representative of habitat significantly degraded from field measured values. Distinct sharp breaks are usually found along the field value axis at about the 80 percent graph line. It was assumed that linear habitat forms would also become significantly altered below the 80 percent habitat value points.



Water Stage	Discharge		Velocity		Max. Depth	
0	35.10 cfs	100%	1.09 fps	100%	1.5 ft.	100%
1	21.81	62	0.94	86	1.2	80
2	9.46	27	0.72	66	0.9	60
3	2.93	8	0.48	44	0.6	40

Water Stage	Ave. Depth		Area		Water Surface	
0	1.0 ft.	100%	32.20 sq. ft.	100%	33.7 ft.	100%
1	0.7	70	23.20	72	32.0	95
2	0.5	50	13.16	41	26.4	78
3	0.3	30	6.12	19	22.8	65

Water Stage	Wetted Perimeter		Habitat Retained	
0	35.0 ft.	100%	63% opt.	100%
1	33.9	94	54%	86
2	27.1	77	43%	68
3	23.2	66	34%	54

FIGURE 1
ROCK CREEK
Station No. 2 - 250 feet above U.S.G.S. gage and inflow pt. 9-2785

<u>100% Field-Measured Values</u>

Water Surface	33.7 ft.
Wetted Perimeter	35.0 ft.
Maximum Depth	1.5 ft.
Average Depth	1.0 ft.
Discharge	35.10 cfs
Velocity	1.09 fps
Pools rated 1, 2, 3	5% sample
Habitat	63% optimum

△ U.S.G.S. 9-2790

<u>Historical Flow Records</u>

Minimum 7.0 cfs 3/13/40 ice jam
Maximum 2,390 cfs 6/14/53
Average 172 cfs

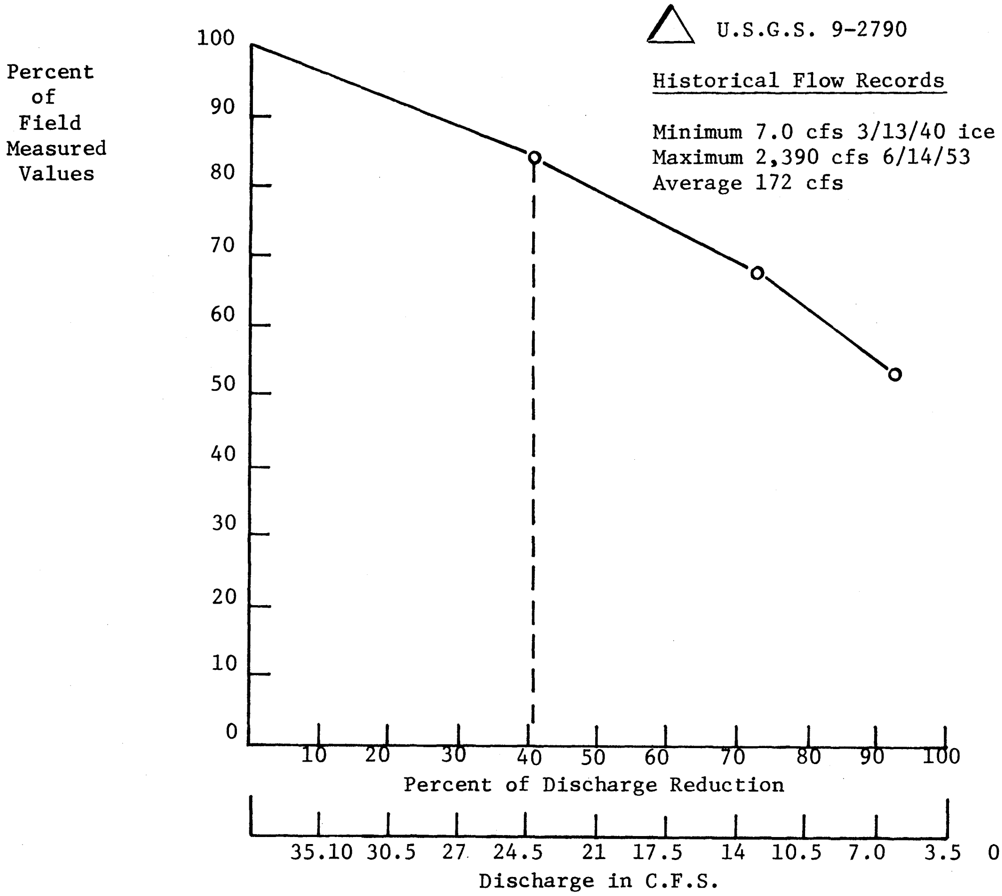


FIGURE 2
ROCK CREEK
Station No. 2 - 250 feet above U.S.G.S. gage and inflow pt. 9-2897

Interpretation of the curvilinear format indicated habitat preservation required a minimum flow equal to no less than 80 percent retention of measured low flow habitat values. Analysis of habitat data along shallow sloping trend lines between sharp breaks required some judgement be exercised in estimating absolute minimum flows which would not degrade habitat values to the point where the aquatic habitat is severely damaged or irreparably lost.

Recommended release flows below diversion points were then compared with historical water records maintained by the U. S. Geological Survey. Flow duration curves were also used for further comparison of sustained releases.

Recommended Releases

Sustained minimum flows were computed at each discharge station on a stream to indicate the variety of stream requirements since gaging stations were often many miles from the proposed diversion sites. The basic release recommendation is the discharge necessary to sustain an aquatic habitat level during the low flow months. Variance in computed flows at different stations on a stream was considered in the overall recommended release for the stream course within National Forest boundaries.

The objective to retain sufficient streambottom coverage and a favorable depth for existing pools during the nonirrigation storage months is not intended to imply the fisheries will remain the same after the streams are altered. Retention of at lease 80 percent of the low flow aquatic habitat does not guarantee 100 percent or even 80 percent retention of the fishery. Indigenous fish populations and biological impacts may vary considerably. Conservation of the basic habitat should provide survival during the nonirrigation season and carryover of resident populations.

An intensive comprehensive short study of aquatic habitat and discharge relationship was conducted by the State of Colorado for the White River from July 11, 1962 to April 15, 1963 under controlled flow conditions.[2] Their study, which included water diversions below normal flows, indicated aquatic habitat types are influenced particularly by depth, volume, velocity, and bottom characteristics. An important feature of the study showed that as the rate of discharge of a stream is reduced, several water factors are also reduced in the following order of magnitude. Velocity is the most affected parameter, then volume, depth and water surface the least. With a reduction in discharge, especially during low flow periods, deep fast riffle areas and velocity are lowered; riffle areas are reduced to slow shallow areas; and slow shallow areas tend to become dry rock. The net effect of these changes depends on the characteristics of individual streambed sections and the extent of discharge reduction. In small high mountain shallow streams, the dry rock phenomena would be prevalent.

Application

Many studies have been conducted on requirements for fish life. The application of these life requirements can be evaluated in terms of discharge. Precise channel profiles used in hydraulic geometry and associated with streambottom characteristics can be projected above as well as below base flow periods. Discharges which meet velocity and depth levels for migration, spawning, or rearing can be computed to provide variable seasonal flows to satisfy those criteria for both spring and fall species inhabiting the same stream system.

Methodology Results

The techniques used in predicting sustained winter flows for streams impacted by the Central Utah Project have not been evaluated under actual controlled conditions over time. Studies are presently being completed by the Utah Divison of Wildlife Resources, under contract to the Bureau of Reclamation, within project areas. A 4-month study conducted by the Bureau of Reclamation in July, 1975, under controlled flow conditions below Soldier Creek Dam on the Strawberry River, appears to substantiate the validity of the hydraulic geometry technique. Actual field measurements were made at controlled releases of 4, 12, 25, and 50 cubic feet per second. Their report will published sometime in 1976. The biological and discharge relationship could not be adequately covered in detail over the short study period.

Methodology Problems

Winter low flows are climatic events that parallel natural stream regimens in the Central Utah Project area. The biological implications of additional reduced flows on the total aquatic communities are unknown factors which were not studied in relation to physical hydraulic geometry techniques. Recommended stream flows related to unknown icing conditions in high mountain streams is of major concern. Research data on this phenomena are needed in addition to the entire biological association at reduced flows over time.

Computer Application

A computer program is presently being developed by the Forest Service, Region 4, Intermountain Region, to assess variable flow patterns with reduction of measured pool values, pool locations, and streambottom characteristics. The program may be initiated and tested during the 1976 field season. The objective is to evaluate degradation of physical habitat features to the point where discharges can be associated with irreparable aquatic habitat losses throughout the stream. Discharge projections above measured low index flows can be computed to determine adequate velocities, depth, area and pool qualities which meet life cycle requirements for fish, and other aquatic life forms.

REFERENCES

1. Herrington, R. B. and D. K. Dunham, "A Technique for Sampling General Fish Habitat Characteristics of Streams," Intermountain Forest and Range Experiment Station Research Paper, INT.-41, 1967, 12 pp.

2. Hill, R. and W. T. Burkhard, "Stream Fishery Studies, White River Survey," July 11, 1962 to April, 1963. Project No. F-26-R-1; Job No. 2, State of Colorado, 72 pp.

3. Collotzi, A. and Greg Muenther, "General Aquatic Wildlife System," Unpublished.

DISCUSSION

Question: The first two systems (those of Wesche and Waters) seem to have no relation to standing crop. Therefore, how do you make a decision on proper flows?

Response: (Waters) Adopt weighting factors based on field measurements. Wait three years and then measure again. Should note that many California streams are managed as put and take fisheries and so standing crop may not apply. From our work we can tell the administrators and lawyers what our best appraisal is of the effect of varying a stream's flow.

Question: Do any of the panel members have any idea what kind of flows are needed? What percentage of the flow is acceptable?

Response: (Chrostowski) We compared flow recommendations with actual flow data and flow duration curves to insure that the recommended flow was actually available. Our low flows come in the winter and they are critical or limiting. There is no rule of thumb or standard percentage of flow. We found 80 percent of the low winter flow seemed to be a "survival flow." Because fish are crowded into pools at the low winter flow, the pool size becomes very important.

Question: Has Wesche measured escape flow rather than holding flow? Are the holding sites representative of the diurnal picture of trout habitat?

Response: (Wesche) We have not surveyed at night. All of our work was done in daytime. We were careful to watch where the fish came from so we have confidence in our holding locations especially since the streams were clear.

Comment: (Chrostowski) Present studies currently underway at several universities should help to answer the questions of the biological relationships to physical characteristics.

Question: Would any or all or a combination of the techniques described by the panel be applicable to a large river?

Response: (Chrostowski) They are probably not applicable to a large river.

Question: Since all of your measurements were made on streams with natural flows, is it realized that past project conditions will eliminate or change those conditions and therefore your measurements will not apply?

Response: (Chrostowski) We need to ask the hydrologist what changes will occur in the channel with the new flows.

Question: What about excessive velocities?

Response: (Chrostowski) Excessive velocities can unravel a channel. In one case we had a stream bed degrade 40 feet. Under these conditions all of the fish habitat is lost.

Question: Do you believe the pygmy Gurley current meter is accurate?

Response: (Waters) Yes, because we are measuring only the microhabitat at 0.2 ft above the bottom.

Question: Why did you select 0.2 ft for measurement?

Response: (Waters) This is the approximate location of the centerline of a holding trout of 6 in. or more in length.

Question: Where do your weighting factors come from?

Response: (Waters) From the literature.

Question: Do you have a method for allowing for excessive cover (more than normal)?

Response: (Nickelson) No. We have not considered that factor.

Question: What about winter habitat? Do you believe you are measuring the limiting factor by working with summer flows?

Response: (Nickelson) Answer to the second question is yes. At present we are dealing only with summer flows.

Comment: We should be cautious in recommending flows based on a single or even two or three parameters or criteria. Remember that a natural stream and its biological productivity are the products of a multitude of flow conditions. Even high flows may play an important role in maintaining a fish population.

Coordinator: William S. Platts, Fishery Biologist, U.S. Forest Service, Boise, ID

Assisted by: J. C. Fraser, California Dept. of Fish and Game, Yountville, CA

Thomas A. Wesche, Research Biologist, Water Resources Research Institute, Univ. of Wyoming, Laramie, WY

Brian Waters, Senior Biologist, Pacific Gas and Electric Co., San Francisco, CA

Henry P. Chrostowski, U.S. Forest Service, Provo, UT

Thomas Nickelson, Oregon Dept. of Fish and Wildlife, Corvallis, OR

Notes by: J. C. Fraser

ROUNDTABLE III-A.

INCREMENTAL ANALYSIS

Summary Discussion

Topics for Discussion:

1. Definition and objectives of incremental analysis;
2. Existing capabilities for incremental analysis in water resources;
3. Deficiencies of existing methods and possibilities for improvement; and
4. Recommendations for research and development.

Questions for Thought:

1. Is the given definition of incremental analysis accurate?
2. Does the definition provide an adequate basis for all foreseeable research and development of incremental analysis techniques?
3. What are existing capabilities of incremental analysis in water resources management?
4. What instream values or components of instream values lack incremental analysis capability?
5. What level of technological credibility is needed to accommodate current and future water management decisions involving incremental analysis (i.e., reconnaissance level planning vs. level "C" implementation)?
6. How do existing incremental analysis capabilities serve as models for developing incremental analysis techniques for other instream values?
7. What are potential approaches to incremental analysis of fish production-stream flow relationships?
8. What are potential approaches to incremental analysis on recreational activities, esthetics, other?
9. What are some specific research needs? How do these recommendations concur with prior recommendations in the literature?
10. How can research and development of incremental analysis techniques be best accomplished? (Research entities? Funding?)

Discussion leaders: F. David Deane, Research Assistant
Albrook Hydraulics Laboratory
Wash. State Univ., Pullman, WA

Ken Thompson, Aquatic Biologist
Oregon Dept. of Fish and Wildlife
Portland, OR

Larry Schmidt
U.S. Forest Service, Odgen, UT

ROUNDTABLE III-B.

INDIAN WATER RIGHTS

Summary Discussion

A brief but inclusive history of the Indian Water Rights cases set the stage for the discussion. It centered primarily around recent cases involving Indian tribes and their needs for water.

In view of the tribes, they should receive such waters as would allow their viable and independent survival. Many interpretations of the Indian needs have dealt with irrigable lands, but the discussion included the Truckee River Case (Pyramid Lake) as one in which fishery retention may be among the Indians' demands. If successful, the Indian tribe may specify flows in the Truckee River for retention of lake levels in highly evaporative Pyramid Lake.

The Trinity River Case in California was discussed. As presented elsewhere in the symposium, this case deals with severe dewatering and trans-basin diversions. The needs and powers of the Hoopah Indians are being questioned and are included in the strategies of those seeking to re-establish fishery flows.

Also discussed were the claims of the Colville Indians in the Pelton Dam Case. In this action, the tribe seeks a dollar value on Indian waters allowed to pass through Grand Coulee Dam. Such payments, if assessed by the Indians for power, might also be made for fish and wildlife flows.

Discussion leader: James B. Hovis, Attorney
Hovis, Cockrill & Roy;
Tribal Attorney, Yakima Indian
Nation, Yakima, WA

ROUNDTABLE III-C.

APPLYING MINIMUM FLOWS TO THE REAL WORLD--IS IT POSSIBLE?

Summary Discussion

An overview of information transfer systems was presented by Mr. Trihey. The discussion which followed sought to establish the relevance and utility of information contained in computerized data banks for the recommendation and/or establishment of stream resource maintenance flows. The concensus was that considerable information was available but the user must go through an educational process before being proficient with automated retrieval systems. It was felt that greater use should be made of descriptors in order to provide for the retrieval of information on a geographical basis.

Information contained in computer data banks must be accurate and current. Data must be collected in accord with standardized technqiues and acceptable methodology if it is to possess the credibility necessary to form a basis for formulating a stream resource maintenance flow.

The majority of the discussion centered on present and past experiences with minimum flows, particularly in California, Oregon, and Washington. Various experiences in Oregon were reviewed, and comments were made on present and potential concerns with water right management programs in California. Past and present programs for establishing minimum flows in Washington state were reviewed. The outstanding trait of a successful instream flow program is an eventual cutoff on the issuance of water rights. States which continue to appropriate unavailable waters are embarked on a self-defeating program. It leads to overappropriation, an unmanageable enforcement program, a large group of dissatisfied junior users, and eventual court action. Washington's base flow program was of particular interest due to solid legislation which provides for a ceiling on water rights issued in streams being managed for instream flows.

The following information was distributed at the session as a handout.

METHODS OF PROTECTING INSTREAM FLOWS

WASHINGTON

1. Water Right Review: Closure to Appropriation (Excluding Domestic). Historically this was used successfully but fisheries agencies can no longer obtain a permanent closure by requesting it for fish needs.
2. WAC 90.54 Base Flows. Limits water rights. Active program with a maximum of about 8 basins/year. 62 basins in state. Positive results with arbitrary methodology.

3. WAC 90.22 Minimum Flows. Limits water rights in a basin. Limited application, 2 rivers/6 years.

4. Water Right Review: Minimum Flows. They are mentioned on the issued water right but State keeps issuing water rights with no cutoff. No monitoring. No regulation. Leads to overappropriation and suggests that our interests are protected. (Similar to MSF)

OREGON

1. Withdrawal from Appropriation. Has limited use. A few Columbia River Tributaries were withdrawn for high scenic values.

2. Classify or Zone Rivers to Remove Them from Specific Water Uses. Ex. irrigation, municipal, mining. Limited program application. Small quantities may still be issued.

3. MSF (Minimum Stream Flows). The State continued to issue water rights with no cutoff. Courts have over-ruled during critical years.

MINIMUM FLOWS AND WATER RIGHT REGULATION

WASHINGTON

An example problem showing one method of determining water right management after adoption of a base flow. Emphasis is on the dry summer season only.

The adopted base flow is the $Q_{77\%}$ discharge at USGS gage 12-3456 equalling 120 cfs during summer months.

Our regulatory agency (Ecology) then basically follows these steps:

1. Determines total water rights issued above the gage: 50 cfs to irrigate 1000 acres.

2. Determines from a recent SCS publication the acreage actually irrigated: 340 acres.

3. The percentage of actual irrigation/total irrigation determines the percentage of existing water rights to count. 340/1000 = 34%. 34% of 50 cfs is 17 cfs.

4. The base flow is added to the calculated actual water use. 120 + 17 = 137 cfs.

5. Calculates the average discharge ($Q_{50\%}$) during dry summer season: 150 cfs.

6. The water left to allocate is 150 - 137 = 13 cfs. Only these 13 cfs of water rights will be subject to the base flow. After this 13 cfs has been issued the basin is closed to further appropriation.

Concerns: 1) Should water be allocated to a level other than the $Q_{50\%}$ discharge? A program which allows water to be given to a farmer with only a 2-year in 10-chance of being available threatens the success of the overall program. This will result in conflict, causing the courts to interfere. 2) Should the 13 cfs be divided into usage blocks of subbasin areas or by usage types? 3) What happens when the old water right holders utilize more of their land and water? 4) Domestic and stockwater water rights are still issued automatically. 5) Monitoring--a critical area with little emphasis. 6) SCS estimates may vary in reliability.

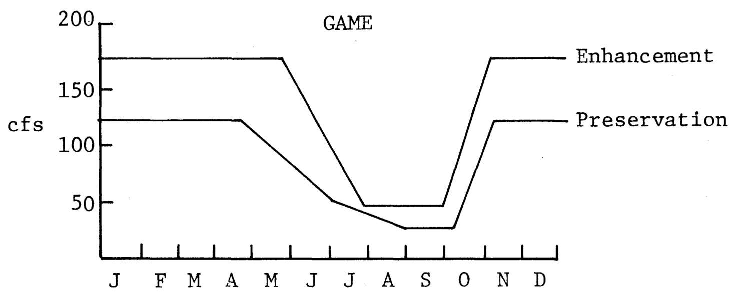
Roundtable III-C continued.

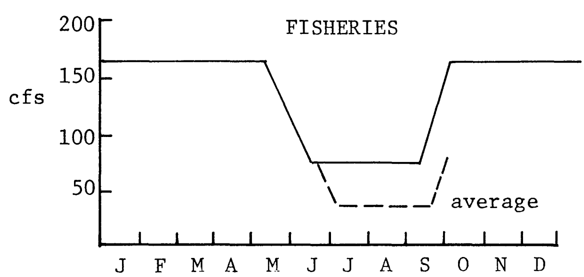
WASHINGTON WATER REGULATIONS

Protecting water resources through scientific minimum flow requests is not practical due to trends in current water right management programs.

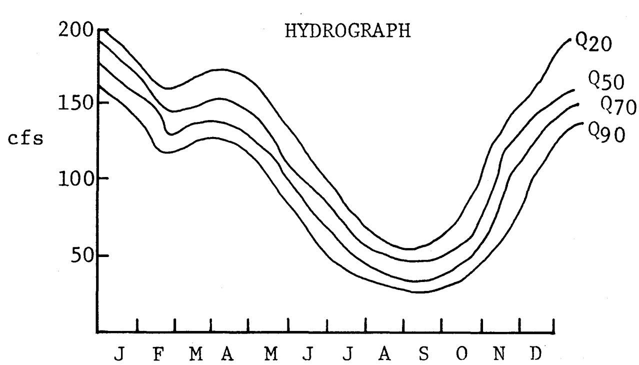
WAC 90.22 Minimum Flows. Requires that the Department of Ecology select a flow to satisfy the interests of fisheries, irrigation, municipal, power, etc. A very difficult decision to make from agency recommendations. Will be contested by those whose total interests are not satisfied.

Most recommendations to date have been based on data from scientific field studies conducted with the U.S. Geological Survey on specific rivers. Fisheries currently also use generalization formulas based on these same study results.





WAC 90.54 Base Flows. Involves several state agencies in a rating process. Ratings are converted to a percent equal or exceeded discharge.



Discussion Leaders: Jay Hunter, Washington Dept. of Game, Olympia, WA
Woody Trihey, Idaho Water Resources Res. Inst., Moscow, ID

ROUNDTABLE III-E.

WILDLIFE AND INSTREAM FLOW NEEDS

Summary Discussion

There seems to be a common misconception about instream flow needs for wildlife that if instream flows needs (IFN) for fisheries are satisfied, IFN for wildlife will be satisfied. This is not true. In many instances reduced streamflow will affect wildlife more seriously than fish resources through changes in riparian vegetation. Changes in water fluctuation and flows for power peaking on the Columbia River system are expected to affect wildlife resources to a greater extent than fish resources. On the lower Columbia River, a dam stabilized flows and improved the river below for fisheries but riparian communities changed from mesquite to salt cedar with resultant impact on wildlife communities. Terrestrial and aquatic resources are related but are different and should be treated as such.

Studies have recently begun which would provide some background information for identifying and studying IFN for wildlife. Robert Ohmart, Arizona State University, is working on one such study on the Lower Colorado River. Four years of baseline data have been collected on vegetation and wildlife, and a study of a stream in which the flow was increased has been made. An associated increase in vegetation and wildlife production was noted.

Another study dealing with changes in water fluctuations and flows is the Columbia River Wildlife Study funded by the Corps of Engineers. The recently completed Phase I was an inventory of riparian habitat and associated wildlife along the mainstems of the Columbia and Snake Rivers. Phase II has been proposed to determine the effects of changes in water fluctuations and flows on wildlife caused by power peaking. These studies have provided study teams with some insight into instream flow problems.

When designing studies regarding IFN, we must learn what we need to know to determine IFN and what factors change when stream flows are altered which will result in changes in vegetation and ultimately wildlife. In some cases wildlife will be directly affected by changes in stream flow, but the greatest impacts will be indirect, resulting from changes in vegetative communities. Because of this, and because wildlife populations vary from year to year, we should place more emphasis on studying effects on vegetation while at the same time identifying relationships between wildlife groups or species and vegetation.

Thus, we would develop a data base including cause and effect relationships useful in predicting effects of altered stream flows in similar habitats to those studied. In short, a basic understanding of the ecosystem in question is needed to predict impacts.

Some factors that should be considered in instream flow studies include: vegetation composition and structure; slope of stream bank; soil moisture; depth to water table; health of vegetation; foliage production; and wildlife habitat relationships.

Methods are available for most sampling needs regarding IFN. They have not, however, traditionally been used for this purpose. These methods should be pulled together, and studies conducted so that correlations between alterations in stream flow and changes in vegetation, and between changes in vegetation and differences in wildlife populations and diversity, can be made. These correlations will identify variables that are critical in instream flow studies of wildlife.

The following outline was used during the roundtable discussion.

INSTREAM FLOW NEEDS FOR WILDLIFE

Formal Methods for Assessing IFN - Wildlife do not exist: Some methods used for evaluating effects of water resource development could be used, or modified, for assessing IFN.

Effects of Changes in Flow Regime on Wildlife

Direct Effects:

1. Removal of drinking water?
2. Flooding home ranges of small mammals.
3. Flooding dens of fur animals during whelping.
4. Exposure and desiccation of amphibian eggs.
5. Flooding nests of waterfowl and other ground nesting birds.

Indirect Effects:

1. Changed patterns of flooding affects maintenance of associated wetlands which results in reduction in quantity and quality of wetland habitat. Effect on wildlife include:
    a. Loss or reduction of primary productivity causes will result in reduction in diversity and numbers of wildlife all the way up the food chain.
    b. Loss or reduction of thermal and protective cover will also result in losses of wildlife.
    c. Loss of above-ground nesting, feeding and perching sites.
2. Changes in riparian vegetation composition and structure caused by changes in water fluctuations and flows will results in changes in diversity and numbers of wildlife. See a, b, and c above.

Existing Methods of Assessing Effects of Changes in Water Fluctuations and Flows

Methods used in assessing effects of water resource development can be used to document and evaluate changes in vegetation and wildlife.

1. Before and after studies using standard techniques to determine:
    a. Habitat units lost; and
    b. Animal units lost.
2. Comparison studies, using standard techniques, in areas in which flow regime has been altered would be compared to similar areas with natural flows. See a and b (Item 1) above.

Other accepted research methods include simulation studies--in which the anticipated situation would be created and standard techniques used to document effects.

Needs

Identify important factors that should be considered when alteration of stream flow occurs. Factors that would have a bearing on the response of plants and animals to changes in stream flow.

1. Major factors affecting distribution of vegetation according to Hawk and Zobel, 1974.
    a. Soil type;
    b. Soil moisture;
    c. Soil texture;
    d. Depth to water table;
    e. Elevation; and
    f. Slope.
2. Other factors which may warrant consideration:
    a. Soil pH;
    b. Soil O_2;
    c. Stream gradient; and
    d. Land use.

Methods of evaluating and predicting response of vegetation to changes in flow regime. Methods of assessing vegetation changes are available but long-term studies needed to document the changes. Factors that should be considered in evaluating changes in vegetation caused by change in stream flow include: 1) plant species occurrence; 2) species composition; 3) structure of plant community; 4) forage production; 5) survival of plants; and 6) reproduction of plants.

Methods of evaluating effects on wildlife may be available. Relationships between vegetation and wildlife which answer questions about why a particular species or group of wildlife responds in a certain manner are not always known. It may be desirable to choose indicator species of wildlife in these studies although in most cases the species present in the study area and the local importance of those species will dictate species to be studied. If we can agree generally on what should be studied or considered in determining IFN for wildlife, we can then determine methods available for studying those factors, and ultimately recommend methods and an approach for general use in this area.

Discussion leader: Jack C. Howerton, Wildlife Biologist
Washington Dept. of Game, Olympia, WA

ASF