Proceedings of the Symposium on

Instream Flow: Rights and Priorities

American Water
Resources Association
Arizona Section

Tucson, Arizona
October 30, 1987

INSTREAM FLOW: RIGHTS AND PRIORITIES

Proceedings of the Symposium Held October 30, 1987
Sheraton-Pueblo Inn
Tucson, Arizona

Arizona Section
American Water Resources Association

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U.S. Geological Survey

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FOREWORD AND ACKNOWLEDGEMENTS

"Instream Flow: Rights and Priorities" was the topic of a symposium held in Tucson on October 30, 1987. The symposium was designed to be an interactive working forum between program participants and the audience as the issues and challenges of instream flow were identified and discussed. Presentations were made by individuals with varied experiences and backgrounds and reflect a diversity of interests and opinions.

The symposium was organized by the Arizona Section of the American Water Resources Association. The principal objectives of AWRA are the advancement of water resources research, planning, development, management, and education, and the establishment of a common meeting ground for physical, biological and social scientists, engineers, and other persons concerned with water resources. AWRA provides a focal point for the collection, organization and dissemination of ideas and information relative to the broad spectrum of water resources problems. Its meetings and publications provide the necessary forum for communication in water science and technology.

These proceedings were compiled by Dale Wright, administrative assistant at the University of Arizona's Office of Arid Lands Studies and Joe Gelt, associate editor at OALS and the Water Resources Research Center. Paul Mirocha of OALS' Arid Lands Design worked on the graphics.

WELCOME AND INTRODUCTION

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Good morning ladies and gentlemen and welcome to the 1987 Fall Symposium of the Arizona Section of the American Water Resources Association. My name is Steve Davis and I am Arizona Section President for 1987-88. I'd like to introduce the other section officers for this year: Hank Eyrich is Vice President, and Ken Foster is Executive Secretary.

The Planning Committee for this Symposium consisted of Hank Eyrich, past section President Jackie Rich, Ken Foster, and myself.

The American Water Resource Association was founded in Urbana, Illinois in 1964. In 1982 the association established a permanent headquarters at the Renewable Natural Resource Center in Bethesda, Maryland. The first issue of the "Water Resources Bulletin", the AWRA Journal, was published in 1965. The bulletin is published bi-monthly and typically contains 115 scientific papers and 1100 pages per annual volume. We also publish a bi-monthly newsletter entitled "Hydata-News and Views".

The first annual AWRA Conference and Symposium was held in Chicago in 1965. The 24th Annual Conference entitled "Water Use Data for Water Resources Management" will be held at the Sheraton El Conquistador in Tucson on August 20, 1988. We hope you can attend the national function, and perhaps some of you can present technical papers there. The American Water Resources Association currently has over 3,000 members nationally. The Association's Conferences, Symposia, and Publications are widely regarded for their technical content and contributions to the water resources community. Your registration for Arizona's Fall Symposium today provided you a 1988 membership in the Arizona Section and a copy of the symposium proceedings.

Principal objectives of the AWRA are the advancement of research, planning, development, management and education, and the establishment of a common meeting ground for physical, biological, and social scientists, engineers, and others concerned with water resources.

AWRA provides a focal point for the collection, organization, and dissemination of ideas and information relative to the broad spectrum of water problems.

I trust today's symposium will fulfill these objectives.

The subject for our meeting today was selected at our Spring meeting at Northern Arizona University with knowledge of its timeliness but little appreciation of it complexity.

In a 1961 paper entitled, Man and the Changing Fish Fauna of the American Southwest, Miller writes:

"The Gila River once was a large, essentially permanent stream of clear to sea-green water, with a well-defined, narrow channel flanked by numerous cottonwoods and set off by a dense growth of willows and cane that rendered it difficult to approach. Along its course were numerous lagoons and extensive marshes that abounded in waterfowl, beaver and fish life."

Similar descriptions of the Santa Cruz River of the past have been written and also downstream portions of the Salt River through the Phoenix area. Arizona's water resources and water use priorities have changed and continue to change. There has been considerable effort in the Southwest to reverse the environmental trend of reducing availability of river sections where there is in-stream flow for wildlife habitat. This requires the development of appropriate biological, hydrological, legal and institutional mechanisms, some of which will be discussed and debated here today.

Mary Wilkosz from the University of Arizona has defined "in stream flow" in her recent paper "The Role of Federal Natural Resource Agencies in Arizona's Instream Flow Policy" as:

"The non-consumptive, in-situ uses of water for fish, wildlife, recreation, and aesthetic purposes." In-stream flows are one of the major uses of surface water on public lands, necessary to fulfilling various objectives of land management agencies.

Although Arizona enjoys some flowing rivers and streams in higher elevation areas remote from urban centers and farms, these resources are being threatened by growth in upper elevation communities, increasing support for water transfers between basins, and Arizona's change in streambed sovereignty.

We've organized this symposium as a forum for discussion of these issues. We invited members of the

technical, legal, and regulatory community to participate individually and in panel discussions as the program indicated.

The afternoon session moderator will be Hank Eyrich. The morning session moderator is Jackie Rich, an Environmental Consultant from Rich and Associates. Jackie will introduce individual paper presenters and members of our issue identification panel.

Instream Flow Protection in Arizona: An Overview of Prospects and Problems

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Remarks at the Fall Symposium of the Arizona Section of the American Water Resources Association, Sheraton Pueblo, Tucson, Arizona, October 30, 1987

[Note: Some of the following discussion was contained in an article, "Protecting Streamflows in Arizona," I published in the Arizona Waterline, Spring 1987.]

Introduction

Some method or methods of instream flow preservation now exist in practically every Western state. Appendix A contains a summary of the situation West-wide. The battle over the law has been hard-fought, but it has been won nearly everywhere by advocates of instream flow protection.

A few die-hards continue to insist that, in Arizona, such authority is still lacking. But this narrow view is belied by the actions of all three branches of government; i.e., the applicable statutes are clear, the courts have indicated they are to be construed in accordance with their plain meaning, and the Department of Water Resources has concurred by granting applications to appropriate water for instream flow preservation.

The action on instream flows today is in two venues: First, the Department of Water Resources has before it dozens of pending applications to appropriate water for instream flows, submitted by local, state and federal agencies and private groups. Second, the Superior Court for Maricopa County is in the early stages of a massive adjudication of all water rights in the Gila River system, a proceeding that promises ultimately to bring a welcome measure of clarity to water rights in the state, and in the process to decide a number of heretofore unresolved issues about water rights in Arizona, which may include some issues directly pertinent to instream flow protection.

Some Remaining Issues

1. Do instream flow appropriators need to own nearby land? A related issue, whether private as well as public entities may appropriate instream flows, has already been addressed by the Department, which has granted applications of the Nature Conservancy, a private entity. This is clearly correct under the applicable statute, which does not distinguish private from public entities in this regard. But the Nature Conservancy owned land along the reach of the stream whose flows it was seeking to protect, and thus the Department has not yet faced the issue of landownership. Yet there is no clear requirement in the Water Code that appropriators must have possessory interests in land where the water is to be used.

2. A closely related question is whether instream flow appropriations can be made on ephemeral streams. The Department apparently takes the position that they cannot. I know of no legal basis for this restriction. Certainly appropriations can and have for a long time been made on such streams for other beneficial uses, and Arizona law does not distinguish between instream and other kinds of appropriations. The Department does not yet appear, in other words, to fully accept the notion that instream appropriations are equal to other kinds of appropriations, and if it sticks to that position, it may be courting judicial disapproval.

Of course the number of ephemeral streams where instream values are worthy of protection may be relatively few. But that does not justify an arbitrary refusal even to consider protection. On some streams a drought/flood cycle may be part of the natural environment, and preservation of flows that do intermittently exist can still be important to protect wildlife, recreation, and associated values.

3. May the Department deny a proposed transfer of a water right because it would adversely affect instream flows? Clearly the answer is yes, if the instream flow is already protected by an appropriation water right. One of the principal grounds for rejecting transfer applications is interference with vested water rights, and an instream appropriation, once granted, is on a par with all other water rights. Of course, one cannot obtain an instream flow appropriation if it interferes with existing water rights.

This, in turn, leads to the question: Why the fuss about instream flows? Because they do not by definition threaten existing uses, why should existing consumptive appropriators be worried? Why, for example, is the establishment of instream flow water rights for federal wilderness areas so vigorously contested? Such rights consume no water (except for evaporation and losses to groundwater that are both minimal compared with more traditional uses like irrigation and municipal and

industrial uses), and thus actually provide an additional layer of protection to preserve flows for existing uses downstream. Moreover, they have such a late priority date that they threaten no prior appropriations.

The principal answer seems to be because legal protection for instream flows limits the future flexibility of existing water rights holders. It does not threaten current users so long as their use, point of diversion, and other features remain the same. But it may prevent any change in that water right, such as a transfer of the point of diversion above the instream appropriation. Traditional water rights holders like this flexibility. It can give their water rights a speculative value, which they may not relinquish without a struggle.

But that may not be a sufficient reason to reject appropriations for instream flows on suitable stretches of river. Many of our few remaining free-flowing streams deserve legal protection, and the sooner that protection is established, the better everyone will be. Even if flows remain legally unprotected, it is not difficult to foresee controversy if transfers are proposed that threaten those flows in areas where they are highly valued; e.g., supporting substantial recreational or wildlife uses. Moreover, the Department probably has the authority in existing law to reject such a transfer if it would unduly interfere with instream flows (or, where appropriate, to condition the transfer upon maintenance of specified minimum flows). A state-wide program to identify and protect instream flows will let all existing water rights holders know what limits exist on their ability to transfer water rights.

4. Does an instream flow appropriation have any protection against the pumping of hydrologically related groundwater? This is a fascinating and complex question that is beginning to be addressed in the general stream adjudication referred to above. I have elsewhere set out my own views on this subject (see The Nexus Between Groundwater and Surface Water in Arizona, Arizona Waterline, Spring 1986, pp. 3-5,9; and Address to Arizona Water Law Seminar, Tempe, October 1985) and will publish a fuller exposition of them in an article to be published next spring in the Arizona State Law Journal.

5. How will instream flows appropriation quantities be calculated? Because this often involves assessing streamflow requirements for recreational (including aesthetic) uses, it requires value judgments as well as technical expertise. It is an issue that appears to be giving the Department of Water Resources some difficulty. Yet, as Appendix A illustrates, nearly all states have dealt satisfactorily with this problem on hundreds if not thousands of streams around the West, and surely there is nothing so different about Arizona streams that prevents using methodologies of quantification routinely applied elsewhere.

For what it is worth, my own view is that quantification ought not to cause agony. The Department needs only to have a minimally defensible assessment of an appropriate quantity to serve the beneficial use in question, and it should err on the side of generosity for the flows because the right does not consume any water. Historically, the Department has rarely scrutinized in any serious way the quantities involved in applications for other, more traditional kinds of beneficial uses like crop irrigation, stockwatering, or industrial applications. Instead, it has tended to accept the applicant's own assessment at face value. Why treat instream flows differently?

6. Will the promise of the public trust doctrine be realized? If this legal doctrine is recognized in Arizona, it could provide an additional source of protection for streamflows. A number of state courts around the country have embraced the concept in recent years, including California, Idaho, Montana, and North Dakota. In fact, every state court that has considered it within the past decade or so has adopted it. There is no law on the subject in Arizona, but a suit has been filed seeking judicial recognition of a public trust, as one ground for challenging the legislation giving up all state claims to ownership of the beds of all streams in the state except the Colorado River. It is impossible to predict whether the courts will accept the doctrine in this state, or even if they do, what effect it will have on streamflows, but clearly it has potential for enhancing the level of protection.

7. How might the flows of already depleted streams be restored? If the public trust doctrine exists in Arizona, it may have implications beyond just protecting existing streamflows in certain areas - it may be a tool to restore flows to the estimated four-fifths of Arizona streams where free flow no longer exists. Restoration can also be achieved, of course, by purchasing and converting existing consumptive use water rights to instream flows. And restoration may occur to some extent through the ordinary processes of transfer, such as when upstream, higher elevation farmers sell their water rights to downstream cities. If the beds of streams are used as the delivery vehicle, streamflows are restored. Similarly, if streambeds are, as seems likely, used as a principal medium for artificial groundwater recharge, then this too might lead to restoration of some flows.

Another possibility that no one to my knowledge has considered is to use a little-known provision of the Arizona water code to restore streamflows. Section 146 of Title 45 says (and has said since the permit system was adopted in 1919) that the state or any of its political subdivisions may obtain any existing water appropriation permit granted since 1919 by tendering the "actual amount paid to the state" for the permit. That amount, so far as I can tell, has always been nothing or, at most, a modest filing fee.

Such a provision is not unique to Arizona. It rests on the idea that surface water is water that by law belongs to the public. It is licensed to private parties for use by means of the appropriation permit, but the reverter clause I've just mentioned has always been a limitation on the right conveyed by the permit. Still, this provision has never been exercised so far as I know - few are even aware of it - but its potential for restoring streamflows seems to me to be worth exploring. It would appear to allow the conversion of some existing diversion rights to instream flows at little cost.

Some Concluding Observations

In the end, the challenge of protecting streamflows in Arizona is largely a political one. I suspect a large, but largely unorganized, constituency exists for protection. It needs to be better mobilized by a campaign of public education, to demonstrate the values of these flows for the economy (in the form of tourism, groundwater recharge, lessening of flood losses, and the like), for society as a whole (in the form of recreational opportunities), as well as for the more abstract goal of a healthy environment. Most Arizonans may well respond favorably to such a campaign, because they see the natural features that so attracted them to the region under siege because of explosive growth.

If the state legislature and agencies remain paralyzed, of course, the avenue of the initiative remains available to cement a protective program into law by direct citizen action. Recent experience demonstrates the efficacy of this approach; that is, the enactment last year of a landmark Environmental Quality Act was directly traceable to a threatened citizens' initiative.

A political and educational campaign ought not to focus on water to the exclusion of other values, for the protection of streamflows is not a complete end in itself - the ultimate objective is to protect all the diverse values of riparian zones. A number of federal and state agencies are paying more attention to this more holistic approach. The BLM and Forest Service, for example, have begun to spend a lot of time and energy on riparian management, a trend that represents a major and progressive change in agency philosophy. Indeed, protection of the spectrum of riparian values, and not just streamflows, may well be one of the next great focal points for land managers and environmental advocates. This new attitude represents a wave that is well worth catching, as we prepare for the Arizona of the 21st century, heavily urbanized and placing ever-increasing demands on riparian zones for wildlife and recreational uses.

Governor Babbitt's recent task force on Recreation on Federal Lands, for example, issued some strong (and unanimous) recommendations for better protection of natural riparian areas, which it called a "fragile and threatened recreational resource" in this state. The measures proposed included a statewide program for identifying and protecting streamflows, regulating groundwater pumping that threatens those flows, enforcing the public trust doctrine, and securing better access to and protection of riparian values. (Arizonans' Recreational Needs on Federal Lands, June 1986, pp. 49-55) Similarly, President Reagan's Commission on Americans Outdoors also advocated better protection of riparian values, in particular endorsing a "greenway" concept, especially in urban areas.

Finally, it should be noted that, because the federal government controls so much land in Arizona, while water management remains primarily a state prerogative, protection of instream flows provides a nice opportunity for useful cooperation between governments. The federal government has in effect proposed such cooperation by applying for instream flow appropriations under state law for many stretches of streams found on federal land in Arizona. The ball is now in the state's court. It would truly be a shame if the kind of state-federal conflicts over water that have marked much of the last couple of decades prevents this opportunity from being seized.

APPENDIX A

State-by-State Survey
of Instream Flow Laws
in the Nineteen Western States

[Sources: Water Efficiency: Opportunities for Action (Report to the Western Governors from the Western Governors' Association Water Efficiency Working Group, July 6, 1987), pp. 83-88; Brief of the Nevada Wildlife Federation and the Sierra Club in Nevada v. Morros, No. 18105 (Nevada S. Ct., filed Oct. 6, 1987); various issues of Water Market Update (Western Network, Santa Fe, monthly); as well as law library searches.]

Summary

The following sixteen western states have explicitly incorporated instream flow protection into their prior appropriation system: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Kansas, Montana, Nebraska, Nevada, North Dakota, Oregon, Texas, Utah, Washington, Wyoming.

In only three states, New Mexico, Oklahoma, and South Dakota, is the matter currently unclear, although Oklahoma adopted a protective state "Scenic Rivers Act" in 1970.

Alaska

In 1980 Alaska adopted a statute allowing the state, its subdivisions, the federal government, or any private person to apply to the commissioner of natural resources to reserve sufficient water to maintain a specified instream flow for fish, wildlife, recreation, park, transportation, and other purposes. Alaska Stat. § 46.15.145.

Arizona

Arizona's Water Code explicitly recognizes "recreation, wildlife, including fish" as beneficial uses. Ariz. Rev. Stat. § 45-141(A). In McClellan v. Jantzen, 26 Ariz. App. 223, 547 P.2d 494 (App. 1976), the court concluded that this statute allowed instream appropriations by any person.

Since that time, two instream flow water rights have been granted to the Nature Conservancy for "wildlife habitat preservation." Permits Nos. 3378419 and 3378421 by the Arizona Department of Water Resources (issued October 17, 1983 with priority dates of June 27, 1979) (one is for .48 c.f.s. of water on Ramsey Creek; the other is for .45 c.f.s. on O'Donnell Creek).

California

Two court decisions in California, California Trout, Inc. v. State Water Resources Control Board, 90 Cal. App. 3d 816, 153 Cal. Rptr. 672 (Ct. App. 1979), and Fullerton v. State Water Resources Control Board, 90 Cal. App. 3d 590, 153 Cal. Rptr. 518 (Ct. App. 1979), denied instream flow appropriations by entities without possessory interest in the lands appurtenant to the water.

In 1985 the Legislature responded to the decisions by specifically authorizing the State Water Resources Control Board (the state water rights regulatory agency) to "establish such streamflow requirements as it deems necessary to protect fish and wildlife as conditions in permits and licenses in accordance with this division." Cal. Water Code § 1257.5. These reservations of unappropriated water are not called "water rights" in the code, but they amount to the same thing. This new statute, coupled with the state's statutory recognition that "[t]he use of water for recreation and preservation and enhancement of fish and wildlife resources" is a beneficial use, Cal. Water Code § 1243, brings California in line with other western states providing legal protection to in-situ water use.

The State Water Resources Control Board relies on the State Department of Fish and Game to review and comment on individual applications. The Board routinely uses these review comments to stipulate conditions on water rights permits to protect instream values. In addition, California has established by statute a state wild and scenic river system that applies stringent protection to the numerous stream segments designated under that act. Cal. Public Resource Code, § 5093.55.

Colorado

In 1973, the Colorado Legislature declared that water may be put to beneficial use "to preserve the natural environment to a reasonable degree," Colo. Rev. Stat. § 37-92-103(4). This statute was upheld against constitutional attack in Colorado River Water Conservation District v. Colorado Water Conservation Board, 197 Colo. 469, 594 P.2d 570 (1979). More than one thousand instream flow water rights have been quantified and recorded under this act. See Colorado Water Conservation Board's computer listing of instream flow rights (Jan. 1987).

Hawaii

In 1982 the Hawaii Legislature enacted a measure which required the Board of Land and Natural Resources to adopt "standards" for the "protection and enhancement . . . of beneficial instream uses." These beneficial uses include fisheries, wildlife resources, recreational activities, ecosystems, aesthetics, and water quality. Haw. Rev. Stat. §§ 176D-1 to 176D-7. Like the "reservations" in the California statute, these "standards" are tantamount to water rights. In May 1987, the Hawaii Legislature enacted a new water code that incorporated the instream flow program with several strengthening amendments. H.B. No. 35 (not yet codified).

Idaho

Instream flow water rights were first judicially recognized in Idaho in State of Idaho, Department of Parks v. Idaho Department of Water Administration, 96 Idaho 440, 530 P.2d 924 (1974), when the court upheld a statute authorizing the Parks Department to "appropriate" water in Malad Canyon for recreational purposes. In 1978 the Legislature broadened the program by a general statutory recognition of instream flow as beneficial uses. Idaho Code §§ 42-1501 to 42-1505. Recently, for example, the Director of the Idaho Department of Water Resources approved a 264 c.f.s. instream flow right application by the State Department of Park and Recreation on a tributary of the Snake River. (No. 36-7200, July 22, 1987)

Kansas

Kansas law directs the state engineer to reject new appropriations of water to protect stream flows whenever the Legislature approves any state water plan identifying a minimum desirable stream flow for any watercourse in the state. Kan. Stat. Ann. § 82a-703a. To date instream flows have been established on nine rivers.

Montana

The Montana Legislature has recognized fish, wildlife, and recreation as beneficial uses, Mont. Code Ann. § 85-2-102(a). It has also established a system for "reserving" waters for instream flow purposes. Mont. Code Ann. § 85-2-316.

Nebraska

Nebraska's instream flow law, Neb. Rev. Stat. §§ 46-2,107 to -2,119, was enacted in 1984 and amended in 1985. It provides, in part, that "the public interest demands the recognition of instream uses for fish, recreation, and wildlife." Neb. Rev. Stat. § 46-2,107.

Nevada

In 1969 the Nevada Legislature amended the state's Water Code to recognize recreation as a beneficial use: "The use of water . . . for any recreational purpose, is hereby declared to be a beneficial use." NSR § 533.030(2). The Nevada Supreme Court has rejected diversion as a necessary requirement of appropriation. Waters of Horse Springs v. State Engineer, 99 Nev. 776, 671 P.2d 1131 (1983). The State Engineer and a Nevada trial court have upheld an instream flow appropriation by the United States, and an appeal of that decision is now before the state Supreme Court. State v. Morros, No. 18105.

New Mexico

The state of New Mexico's law on instream flows is unclear. There is no statutory definition of beneficial use, nor any discussion of a diversion requirement. None of the case law is directly on point. In State ex. rel. State Game Commission v. Red River Valley Co., 51 N.M. 207, 182 P.2d 421 (1945), the court declared that "beneficial use" includes fishing and recreation, but apparently no explicit water right for the fishery was sought in that case. In State ex rel. Reynolds v. Miranda, 83 N.M. 443, 445, 493 P.2d 409, 409-10 (1972), the court said that "man-made diversion, together with intent to apply water to beneficial use and actual application of the water to beneficial use, is necessary to claim water rights by appropriation in New Mexico for agricultural purposes." Id. at 441 (emphasis supplied). It is not clear, however, that the same conclusion would follow for non-agricultural purposes. At least one writer has concluded that instream flow water rights may be recognized under the existing state law. Comment, Appropriation by the State of Minimum Flows in New Mexico Streams, 15 Nat. Resources J. 809 (1975).

North Dakota

North Dakota authorizes the state engineer to deny appropriations because of their "effect on fish and game resources and public recreational opportunities." N.D. Cent. Code § 61-04-06(4)(b).

Oklahoma

Oklahoma has no explicit recognition of instream flow water rights. In 1970, however, the state enacted a state Scenic River Act, Okla. Stat. tit. 82, § 1451-1471, which "preserves" designated river segments.

Oregon

Instream flow rights are explicitly recognized in Oregon. "[R]ecreation, wildlife and fish life uses and pollution abatement . . . are declared to be beneficial uses . . .." Ore. Rev. Stat. § 536.300. Minimum stream flow standards for all Oregon streams have been established by the responsible state agency since 1955. In the 1987 legislative session, these minimum stream flow standards were transformed into vested water rights. (SB 140, not yet codified.) Also, for many decades the Oregon legislature has withdrawn entire streams from further appropriation by statute. See O.R.S. §§ 538.110 through 538.300.

South Dakota

South Dakota provides no explicit recognition of instream flow water rights.

Texas

The Texas Water Code recognizes "recreation and pleasure . . . public parks . . . [and] game preserves" as beneficial use of water. Moreover, the Texas Water Commission is authorized to consider "existing instream uses and water quality" in its consideration of new water permits. Tex. Water Code Ann. § 11.147(d).

Utah

In 1971 the Utah Legislature authorized the State Engineer to deny application of water rights where there is "reason to believe that an application for appropriate water . . . will unreasonably affect public recreation or the natural stream environment." Utah Code Ann. § 73-3-8. See J.J.N.P. Co. v. State, 655 P.2d 1133, 1137 (Utah, 1982).

In 1986, the state Legislature authorized the Division of Wildlife to apply to the State Engineer to convert existing water rights held for other purposes to instream flow purposes. Utah Code Ann. § 73-3-3(7).

Washington

In 1949, the Legislature declared it to be the policy of the state "that a flow of water sufficient to support game fish and food fish populations be maintained at all times in the streams of this state." Under this authority, approximately 250 streams have been closed to further appropriation and low flow provisions have been applied to individual permits on approximately 250 more streams. The Minimum Water Flows and Levels Act (Chapter 90.22 RCW) was enacted in 1967 to provide a more formal process to protect instream flows. Under this Act, the Department of Ecology (DOE) must, when requested by the Department of Fisheries or the Game Commission, establish minimum stream flows and lake levels to protect fish, game, birds, or other wildlife resources or recreational or aesthetic values or to preserve water quality. DOE used this authority in 1971 to adopt minimum flows for the Cedar River, a major source of water supply for the Seattle metropolitan area. The Water Resources Act of 1971 (Chapter 90.54 RCW) gave additional momentum to protection by directing that "perennial rivers and streams of the state shall be retained with base flows necessary to provide for the preservation of wildlife, fish, scenic, aesthetic and other environmental values, and navigational values." The Act also declared instream flows to be a beneficial use of the state's waters. Under these various authorities, DOE has establish instream flows on 172 major streams (or stream reaches) in the state, and has closed over 300 streams and lakes to further consumptive appropriation (Washington State Department of Ecology, 1987).

Wyoming

In 1986, after several years of debate, the Wyoming Legislature adopted an instream flow law authorizing the Game and Fish Commission to appropriate water for instream fisheries. Wyo. Stat. §§ 41-3-1001 to -1014.

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INSTREAM FLOW AND WILDLIFE RESOURCES

Our panel's objective is to identify the issues surrounding instream flow: rights and priorities. I will focus my attention to instream flow as it relates to wildlife, natural values and the associated recreation.

Arizona conservation leaders became concerned with what was happening to our natural stream systems and associated wildlife in the mid sixties. One of the historic uses of water is by wildlife but until the last decade there was little reflection of that value in our water management.

Of particular importance to wildlife is the habitat along our rivers and streams. This is that lush growth of grasses, shrubs and trees that live only on the river bank where their roots can reach the shallow water table below.

Water: the critical requirement for the riparian zone, and the single most important issue that has, is and will influence the growth and prosperity of desert enviorns be they natural or man made.

Riparian zones can vary considerably in size and vegetative component because of the many combinations that can be created between water sources and physical characteristics of a site. Examples are topography, gradient, soil, elevation and water quality.

Riparian communities in Arizona range from the alder-aspen at high elevations through willow-cottonwood-sycamore associations at mid elevations, to the mesquite and salt cedar encountered at low elevations.

Although riparian zones are generally narrow and linear, following the courses of streams and rivers, they do spread out in developed low gradient floodplains. Historically, all the major river systems of the State had well-developed riparian communities. Reports by early explorers, such as Lt. William H. Emory, documented the fact that river bottoms were overgrown with impenetrable thickets of willows, mesquites, and cottonwoods. According to the records of Father Kino, in 1699 the Colorado River had massive galleries of cottonwoods. Today, however, the total riparian area in Arizona amounts to less than 300,000 acres, about half of one percent of the total of all vegetative communities. About 100,000 acres of the available riparian is along the Gila River.

Riparian communities are usually characterized by deciduous shrubs and trees, such as cottonwoods, ash and willows, that have distinct structure and lots of edge -- a habitat parameter with special value to wildlife. Since riparian zones tend to be linear, the amount of edge is maximized. However, because riparian zones normally are narrow they become more vulnerable to severe alteration. They are in fact "fragile" environments. The more mature a riparian zone, the more valuable it becomes in providing distinct edges and strata that intensify edge-effect and enrich the wildlife resource.

Arizona is a diverse state, biologically, due largely to the diversity in elevation, topography, and water availabilty. Over 1,100 species of wildlife have been recorded in the State, including some 850 species of vertebrates.

The faunal and floral richness of riparian zones is particularly high with nearly 47 percent of all recorded breeding bird species in the state utilizing riparian habitats. Breeding bird densities in Fremont cottonwood stands have been recorded as high as 1,000 pairs per 100 acres.

Riparian zones are of paramount importance in the survival of native fishes in the Southwest, where the vast majority of the species are stream rather than lake associated in their habitat occupancy.

The common attraction of riparian zones for most wildlife is water, however, food or cover may also be provided; often all three.

Riparian zones along intermittent and permanent streams and rivers provide migration routes for wildlife such as birds, bats, deer, and elk. Also, they may be used as connectors or travelways for daily movements where cover requirements are met. In general, wildlife use riparian zones disproportionately more than any other type of habitat.

High value use of riparian zones is not limited to fish and wildlife resources; man has significant demands for food, fiber, fuel, timber, and recreation that encompass riparian habitats.

The change in public attitudes and water project design in the last 20 years in Arizona is phenominal and quite likely the trend will continue. That is why it is reasonable to talk of minimum instream flow today; a subject mentioned only in hushed tones by conservationists twenty years ago. Consider where we were then.

A group of competent engineers had been given the task of developing perserving and managing our water resources. They worked for cities, counties, irrigation districts, state and federal agencies. Their only constraints were money, time and imagination and thanks to a very capable congressional delegation many federal projects were authorized and funded during the sixties. Some were constructed but let us look at a group that created new problems. These were the water salvage projects.

They were designed to derive additional water from watersheds and to reduce use by steamside vegetation. This riparian habitat was renamed phreatophytes by the people proposing to eliminate it. Typical water salvage projects included reducing vegetation chaparral and timber on watersheds and the clearing of riparian vegetation from water courses. The latter activity was also justified as flood control. Studies estimated that water yield in Arizona might be increased as much as 600,000 acre-feet per year by clearing our phreatophytes. At one time there were active projects or plans to clear the vegetation from every major river in Arizona including the Gila-Salt-Verde-San Pedro-Santa Cruz and Colorado. After 14,000 acres were cleared by the Bureau of Indian Affairs along twenty miles of the Gila and around San Carlos Lake, public reaction pre-empted further projects of this sort.

Consider also the 1968 attempt of the Bureau of Reclamation to dredge the Colorado River through the proposed Topock Gorge Wilderness area. The plan was to fill the adjacent back-waters with spoil. Although some of the backwaters were filled, the remaining area was eventually saved by intervention of the governors of Arizona and California and a vocal citizenry.

Initial plans for the Central Arizona Project included clearing the riparian habitat from the San Pedro and Colorado rivers. Indeed it was claimed the project was infeasible without it. That proposal hasn't been seriously considered for fifteen years. I ask you, "Can't you feel the winds of change"?

Today your going to hear of the need to keep a minimum flow in our streams in order to preserve them and your going to hear of water rights that are almost god given and can be utilized as the holder desires. If you've watched the "Life Style" series on Channel 12 in Phoenix this week, you've also heard that Phoenicians perceive a decreasing quality of life related to excessive growth and development. The heart of the 3 billion dollar Rio Salado Project is little more than a 20th Century attempt to recreate instream flow for the Salt River.

As never before we have today the physical ability to modify our state. Because of the delivery of "new" water to central Arizona the potential for purchases, exchanges and development throughout the state bogle the mind. The streams that previously were "protected" with down stream water rights no longer retain that category. In this flurry of repositioning it is hoped we don't lose values, triusic and intriusic we presently have. In 1980 the expenditure of anglers for cold water fishing alone was 100 million dollars. This occurred largely in the economically depressed rural areas from Williams to Clifton. With the current growth in this activity and the increased production from our five reconstructed hatcheries, it is likely to be a 1/2 billion dollar industry by 1990. These resources plus associated tourism, the number one industry in many rural areas are the most likely first casualties of many potential water exchanges.

What is the potential loss? Who knows? In wildlife about half the bird species are totally dependant on riparian habitat, but 80% utilize it. Allmost all larger mammals must have access to free water. Of the species on the Arizona threatened list almost half our native fish have been extripated and 19 of the 20 remaining are associated with live streams as are seventy percent of the threatened herptiles.

It took a San Carlos and Topock incident to awaken Arizona to the realities of some water salvage projects. I hope we don't have to suffer an Owens Valley incident to realize the need to establish instream flow standards.

INSTREAMS FLOW WATER RIGHTS: REGULATORY ISSUES

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The Arizona Legislature enacted the Surface Water Code in 1919. The Code specifies the basic procedures for obtaining rights to surface flows primarily through diversion of water from a stream. The water must be put to beneficial use on land owned by the appropriator. The Code has been modified only slightly in the past 68 years. In spite of the fact that prior to 1919 almost all of the dependable surface flows had already been appropriated and in many cases their rights adjudicated by court decrees, the State Land Department followed now by the Department of Water Resources (DWR) has managed to issue over 6,300 surface water rights under the Code. Not only that, but there are still 2,400 applications for water rights pending before the DWR at the present time.

The surface water law states that "Any person or the state of Arizona or a political subdivision thereof may appropriate unappropriated water for domestic, municipal,irrigation, stock watering, water power, recreation, wildlife, including fish, artificial groundwater recharge, or mining uses, for his personal use or for delivery to consumers. The person or the state of Arizona or a political subdivision thereof first appropriating the water shall have the better right." The application to appropriate requires the applicant to identify a number facts associated with the appropriation including: the source of the water supply, the nature and amount of the proposed use, and in the case of recreation or wildlife purposes the location and the character of the area to be used and the specific purposes for which such area will be used. In determining whether or not to grant an application the Department is required to consider a number of factors such as if the proposed use conflicts with vested rights, is a menace to public safety, or is against the interests and welfare of the public. In approving an application the Department cannot approve an application for more water than may be put to beneficial use.

Over the years the regulatory agencies developed rules and procedures to implement the statutes. For example in order to determine impact with vested rights a procedure which allows protest by other right holders was developed. Based on information provided by a protestant a hearing could be required at which the applicant must demonstrate that vested rights would not be impacted. In determining the appropriate volume of water to achieve the desired beneficial use a value such as an irrigation water duty or a gallons per head per day requirement for stockwatering is used. These values are then compared with the amount of water being requested to make sure that no excessive appropriations were permitted.

These procedures worked satisfactorily for most conventional

applications where there is a diversion from the stream and the water is consumed at another location. In June, 1979 the Department was faced with an application which did not meet the conventional standards. The Arizona Nature Conservancy applied for an appropriative right for recreation and wildlife purposes not based on a reservoir or a diversion of water, but rather for in stream uses. The in stream flow application placed the Department in the position of having to answer all of the regular questions about granting a new permit, but the context was entirely different. The application was protested by other water users in the area and a hearing was held on the issues. The primary issue, whether or not a diversion was required in order to obtain an appropriative right, was discussed at length. In April, 1983 the Department issued its Decision and Order on the application approving the permit to appropriate by concluding that and it is within the Arizona law to appropriate water for in stream uses for wildlife and recreational purposes.

Since the 1983 decision the Department has received and additional 37 applications for instream flows. A current list of those applications is found in Table 1. In April 1986 the Arizona Game and Fish Department indicated to DWR that they had identified 188 stream sections with wildlife or recreational values which may be candidates for instream flow applications. They had not proceeded to make applications because of the potential costs of investigating and having to support that many applications. However, they would be prepared to commit the resources to make the filings if DWR would publish criteria for evaluating the applications and standards of proof for supporting claims. They went on to offer the expertise and assistance of their agency in helping the Department develop those criteria. At the same time representatives of the Bureau of Land Management, Bureau of Reclamation, and the Forest Service indicated a similar willingness to provide help.

Before proceeding with a rulemaking process, the Department attempted to get a clearer understanding of what objectives needed to achieved. We started by first reviewing all applications on file to determine what information had been furnished. All applications for instream flows were based on fish and wildlife and/or recreation uses. For the most part the fish and wildlife uses were related to riparian maintenance and fishery habitat. Recreational uses were geared much more to aesthetic values such as hiking or camping by live stream rather than more quantifiable uses such as rafting,floating, or swimming. The length of stream reaches varied from less than a mile in several cases to more than 20 miles in the cases of the cases of the San Pedro and Verde Rivers. In the case of the longer reaches only a few of the applications request a different flow rate for different reaches based on accretions or losses. Most applications are for a constant year round minimum flow although several ask for seasonal variations. At the time of the investigation all applications except a filing by the Arizona Game and Fish Department, were by the agency or landowner who controlled access to the stream.

Most of the applications provide information on the fish and wildlife habitat the instream flow is intended to preserve. One appli-

cation, the BLM's Burro Creek application provided extensive technical and scientific information which evaluate instream flow requirements. Nearly all applications are based on historical minimum flows recorded at nearby USGS gaging stations rather than an in depth evacuation of habitat needs.

After reviewing the applications the Department contacted the Department of Water Resources offices of several other western states to determine if their procedures for evaluating instream flows could be adapted to Arizona. We discovered that while many other states had specific statutes regulating instream flows, only a few other states save adopted comprehensive procedures to deal with evaluating the issue of how much water was the correct amount to demonstrate beneficial use. The most advanced programs appeared to be in Washington and Oregon. Oregon has advanced their procedures through rules, but those rules pertain to a specific law governing instream flows. Oregon recognizes instream flows for fisheries and water quality purposes. Applications can be made only by the Department of Fish and Wildlife or the Department of Environmental Quality. The Oregon rules describe the information the applicant must provide, the review process for applications, the information base used in considering applications, and the review standards. Review is based on both hydrologic considerations (is the water likely to be available?) and beneficial use considerations (how much water is really needed to support the fish habitat?). Even with specific guidelines it appears from various reports that in most cases the final instream flow rights quantities were the result of a combination of technical information and a negotiated agreement with out of stream diversion users.

In order to move ahead effectively on instream flow applications, the Department needed to take steps toward resolving remaining policy, legal, and technical considerations. The Department considered five options:

1. Sign an interagency Memorandum of Understanding with the Arizona Game and Fish Department for consultation.

2. Organize an interagency task force to work on the issues. The task force would be open to both governmental and non-governmental entities.

3. Hire an independent consultant to prepare a report and recommendations on the issues.

4. Perform any technical analyses in-house using Planning and Hydrology staffs.

5. Do nothing in the form of comprehensive rules, but rather let the issues sort themselves out on a case by cases basis using the hearing process.

Considering the amount of support that the Department had received from the applicants and their desire to assist in the formulation of rules,

the Department decided to use the interagency task force approach.

The task force was organized in December 1986. The original schedule established was to hold two or three meetings and conclude the effort within just a few months. Unfortunately, the Department has not been able to live up to the original schedule. The Office of Water Management for which I have the responsibility of directing is faced with many crucial issues in addition to instream flows. Our highest priorities had to be set for the preparation of the Second Management Plans by early next year and the enforcement of the First Management Plans. In addition to these efforts there are a number of rule packages relating to the implementations of the Groundwater Code which were long overdue. With limited staff and resources available some priorities had to be established and in the overall scheme of things I felt that surface water rules including the instream flow rules would simply have to be postponed. I want to assure all of you, however, that while these rules have been delayed they have by no means been abandoned. The Department recognizes the need to act on the instream flow applications and is committed to do so. The simple facts of life are that it may take us a little longer than I had originally anticipated.

As the Chairman of the Task Force I want to point out that the quality of the input which we have received has been outstanding and extremely valuable. Many of the members participated in preparation of technical materials while others have shared their opinions on policy issues. Many of today's speakers will discuss their findings and their points of view and I'm sure you will find them to be extremely interesting.

In conclusion, I want to reiterate that the Department of Water Resources will work to complete our efforts to establish regulatory guidelines for processing instream flow applications. We believe that the guidelines will prove to be the important factor to allow us to proceed to make decisions on the existing applications and to provide the certainty to the land and wildlife resource management agencies to program their efforts for later applications.

Table 1
MINIMUM INSTREAM FLOW APPLICATIONS

(33) App. No.	Applicant	Source	Requested Flow in Acre Feet	Status
40240	Az. Game and Fish Dept.	Silver Sprs. (2)/Silver Crk.	2,244.40	Application
78418	Az. Nature Conservancy	Thomas Wash/Altar Wash	56.50	Application
78419	" " "	Ramsey Creek/San Pedro	347.52	Permit
78420	" " "	Sonoita Creek/Santa Cruz	403.30	Cand. for Permit
78421	" " "	O'Donnell Creek/San Pedro	325.80	Permit
86565	Coronado National Forest	Grant Creek	8.50	Withdrawn 8-3-83
87114	B L M - Safford District	Aravaipa Creek	10,860.00	Cand. for Permit
89090	Pima Cty. Flood Control Dist.	Cienega Creek/Pantano Wash	3,124.40	Protested
89109	Tonto National Forest	Pinto Creek/Salt River	1,810.00	Protested
89119	B L M - Safford District	Francis/Burro Crks./Big Sandy	5,430.00	Protested
90103	Huachuca Audubon Society As. to BLM w/cond. 5-28-86	San Pedro/Gila Rivers	553,491.00	Protested
90106	Coconino National Forest	Oak Creek/Verde River	4,344.00	Protested
90107	" " "	E. Clear Creek/Little Colo.	72.40	"
90108	" " "	Walker Crk./Wet Beaver Crk.	362.00	"
90109	" " "	Red Tank Draw/Wet Beaver Crk.	72.40	"
90110	" " "	W. Clear Creek/Verde River	8,688.00	"
90111	" " "	Sheepshead Crk./Oak Creek	144.80	"
90112	" " "	Wet Beaver Crk./Verde River	3,909.60	"
90113	" " "	Sycamore Crk./Verde River	2,389.20	"
90114	" " "	Spring Creek/Verde River	2,172.00	"
90249	B L M - Safford District	Buehman Canyon	723.00	Protested
90250	" " "	Bonita Creek	3,613.00	"
90251	" " "	San Francisco River	7,227.00	"
90252	" " "	Mescal Creek	1,445.00	"
90253	" " "	Apache Creek	500.40	"
90309	Tonto National Forest	Verde River	72,400.00	Protested 1-16-87
90310	" " "	East Verde River	2,896.00	" 1-16-87
90311	Navajo Cty. Parks & Recreation	Billy Creek/Little Colo.	1.00	Cand. for Permit
90410	B L M - Phx. District	People's Canyon Creek	72.40	Cand. for Permit
92304	The Nature Conservancy	Mainstream Hassayampa River	3,620.00	App. 1-20-87
92298	S/W Arboretum & State Parks Bd.	Queen Creek/Gila River	904.89	App. 1-20-87: defective
93232	Sierra Club	Sabino Creek	6,358.53	App. 7-28-87
93263	Coronado Nat'l. Forest	Sabino Creek/Rillito Creek	25,506.52	App. 8-3-87

(cont'd.)

MINIMUM INSTREAM FLOW APPLICATIONS

(33) App. No.	Applicant	Source	Requested Flow in Acre Feet	Status
93282	Az. State Land Dept.	Cargodera Canyon	73.1	App. 8-7-87
93283	" " " "	Montrose Canyon	362.7	" 8-7-87
93284	" " " "	Romero Canyon	543.7	" 8-7-87
93285	" " " "	Cargodera Canyon	73.1	" 8-7-87
93286	" " " "	Alamo Canyon	218.4	" 8-7-87
93287	" " " "	Sonoita Creek	1,200.0	" 8-7-87

A MUNICIPAL PERSPECTIVE OF INSTREAM FLOW PRIORITIES

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First, I'd like to make it clear on a disclaimer, that what I say is as a professional and does not represent the official position of the City of Mesa.

Some of you are representing special interests, some are academic, others are representing regulatory interests, attorneys, and I guess whatever other areas you might think of. I like to think that I represent the people perspective. I guess I have to define what that is. I'll use an example of my view of the public trust doctrine. I'll take a few liberties with the attorneys on this.

The public trust doctrine that I'd like to use was that this morning you got up at 5, 5:30 or 6, and the first place that you headed was probably to the bathroom and you turned the faucet on or showerhead on. Your trust in me and the City of Mesa is that the water would come out of that faucet. That was your expectation and your public trust. What would have happened if the water wouldn't have come out? I think you would be very unhappy. I think that this is a good example of what I call "the competing demand." Where does Mesa get it's water? From the Salt/Verde System. If special interest groups, or whatever we want to call them move ahead and take and set aside an instream flow on the Salt/Verde System, it's got to come from someplace, people. Maybe I should ask you as an individual, "Would you be willing, every tenth shower, to give it up so that we could have instream flow?" That's pretty hard, but that's real. It's real in my mind, and I'm speaking from the viewpoint of a water resource planner.

I have to agree with the professor over here that the decision I've just talked about has to be a political decision based on consensus, not special interests. if you have a decision based on special interests, how is it accepted? Not too well. A good example is my good friend's House Bill 2518. A super-difficult one to implement because it wasn't consensus legislation. I thing instream flow has to be a State decision, and a broad consensus decision.

Now, to set the tenor of my talk, I'd like to refer to two documents that you might like to write down. The first is a letter from the National Wildlife Federation dated October 21, 1987. It's addressed to Jim Ziegler and Dale Duvall, and it's signed by the president of the

organization, J. Hair. Copies were sent to numerous people, one of which was my mayor, and I received a copy of it. So that's why I have it here. It's rather current, October 21st. The first paragraph states this:

> "The National Wildlife Federation and the National Audubon Society have learned you intend to execute a contract affecting repayment obligations for the Central Arizona Project, characterized as a supplemental agreement for funding of Plan 6 facilities of the Central Arizona Project. We understand that this agreement was negotiated and completed without publication in the Federal Register and so far as we can determine without any environmental evaluation or public input. We want to bring to your attention the fact that the execution of this agreement exceeds the Bureau of Reclamation's authority and would violate the provisions of the National Environmental Policy Act and the Bureau of Reclamation's own regulations regarding public participation...."

I'll skip a few paragraphs to one that I like very well.

> "The National Wildlife Federation and the National Audubon Society have a substantial interest in the terms of this pending supplemental agreement, due both to our longstanding involvement in education and conservation activities directed to the wise use of your nation's water resources and to our status as plaintiffs in a lawsuit challenging the provisions of Plan 6 at Cliff Dam. The Cliff Dam and potential alternatives to Cliff Dam would alter the surrounding environment profoundly, affecting many of our members' use and enjoyment of the natural resources of Arizona. We urge that the supplemental agreement not be executed without a full environmental assessment and public participation. We suggest that the execution date be suspended so the Bureau can comply with all legal requirements before signing this important document."

That's one document. That's one point of view. Let me move to another, rather different point of view. How many of you know about the National Water Resources Association? A few people. It's a different point of view. They've just recently come out with a position statement on instream flow requirements of Federal agencies and they're having a national conference in November in Reno. The American National Water Resources Organization is having theirs in Salt Lake City. Let me just go over what their position statement is on instream flows.

> "The U.S. Forest Service, Bureau of Land Management, U.S. Environmental Protection Agency, Army Corps of Engineers, Fish and Wildlife Service

of the Department of Interior, and the Federal Energy Regulatory Commission have each acted under the assumption that environmental legislation such as the Clean Water Act, National Environmental Policy Act, the Endangered Species Act, and the Rivers and Harbors Act can be used by Federal agencies to require minimum stream flows for water quality and wildlife purposes."

There's an example in this position paper. The Corps of Engineers denied the 404 dredge and fill permit for the construction of Wildcat Reservoir in Colorado on the grounds that a Fish and Wildlife Service opinion claimed that the operations reservoir would allow a further consumptive use of the water in Colorado and would endanger the whooping crane habitat 260 miles downstream in Nebraska. The Wildcat Reservoir had a Colorado River Water Right Decree, and the appropriation was within the terms of the South Platte River Compact between the States of Colorado and Nebraska.

"The Fish and Wildlife Service has issued opinions against water projects in Utah, Wyoming, and Colorado, designed to prohibit any further consumptive use of the Colorado River water by the upper basin States on the ground that endangered fishes may be affected. Further, the U.S. Forest Service is now attempting to establish reserve water rights for channel maintenance and sediment transport. These are examples that the Federal government has embarked upon a system of water allocation and management by regulation means outside of State water laws. The States are urged to review their water laws and provide a mechanism whereby the minimum flow needs for fishery purposes and other water quality needs be given consideration in water planning, development, and administration where possible and appropriate."

Another point of view. I am a layman in water resources planning. I have trusted my city to provide adequate water to those people when they turn the faucet on. I'm trying to understand the direction of the Federal government. I'm trying to understand the direction of the State government. I'm trying to understand the direction of special interest groups that are active in this area of instream flow. I have concluded after 30 years experience in the field -- and by the way, I'm a native born son of Tucson. That should give me some rights to this in Tucson. I'm also a graduate of the University of Arizona in civil engineering, which can't be all that bad. Last of all, I spent 14 years in southern California working there and getting experience, and I have two advanced degrees in engineering and public administration from USC. I guess I'm partially academic and partially everything exposed to it. So I sit here and I think about this direction that we're going and I ask myself three question: Are we

trying to go to a pre-existing condition? Are we to deal with today's condition? Or are we talking about tomorrow's post-condition? Let's explore each one of these three.

What about the pre-existing condition? My good friend Bud Bristow already talked about that. I grew up in Gila Bend in the early 30's. Guess what? The Gila was a flowing stream. It had habitat. It had weeping willows. We went duck and geese hunting there. Do we restore that type of habitat in this area? Is that our goal? I don't know.

Number 2. What about our present condition? I have three examples in the present condition. First, let's take the Phoenix Metropolitan area, better known as Salt River Project, that has two watersheds -- one the Verde of about 6,500 square miles and the Salt, 7,000 square miles. They very jealously guard their appropriated right on those watersheds for use on lands of the SRP. There's the Kent Decree sitting there that says it's appurtenant to the land. Now, those lands have used that water forever, almost. The economy has been based on it. This morning in Mesa, that's what was served to the people that were there.

The second present condition I'd like to talk about is the 91st Avenue Wastewater Treatment Plant presently discharging about 130 million gallons a day into the Salt River just above the confluence with the Gila River. That started initially in the 1950's. The area below it, in my opinion, was desert. In the last 30 years, what has happened? Probably the best habitat in the State of Arizona was developed in the last 30 years down to Gillespie Dam. I don't know if you agree with me, but some people would say that. The reason that it's there is because of the effluent. What's going to happen? There are certain special interest groups that are putting the squeeze on the people that are discharging to "upgrade the quality of their discharge." Let me just tell you folks that before I will recommend to my people that we spend that kind of moneyto improve effluent qualitys, we're going to take that water out of the river and re-use it. It won't be there for that habitat use, so there has to be a combination. Phoenix has very graciously stated that they will still give to the Arizona Game and Fish Department 7,000 acre-feet there. That's their choice. Seven thousand acre-feet is not going to keep that habitat in the position that it is today.

The third present condition, and maybe it's not so present, Professor Leshy talked about it, is the Gila River adjudication. The Gila River adjudication is very important to all people in Arizona. In my opinion, it's going to come down, I hope, to adjudicating all water, both surface and ground water, so we know just where we stand on the total picture, once and for all. It's an excellent experience to go through. It's going to take

a little time. I think probably in the area of 15 years, but it's going to be full employment for hydrogeologists, and attorneys. Maybe we can sit down, use the water, and say, "Hey, we've got so much water, this is the way we divvy it up," and by-pass that process in a couple of years. That's wishfull thinking. Maybe I've been smoking something that I shouldn't be.

Let me just say, from the present conditions, you all live here, you make your living here in Arizona, you want to return something to the State in an altruistic way. Would you, as an individual, give up maybe ten percent of your standard of living to achieve these goals of instream flow? These are nice goals. I think you've got to give up to get, because I don't think you can get anything today without paying the cost. In other words, no free lunch.

Now let me move to the post condition .... what possibly could be. I want to suggest something here, because I'm not the wild card that everybody makes me out to be. I'm pretty fair about things. I'm going to talk about three things. The first thing I'm going to suggest is that if we really want this as what's in the best interest of Arizona, that we look at new water and that we dedicate a percentage of the new water to the use of instream flow, because I think it's going to be very difficult to take water away from present, existing uses and present, existing economies without people getting hurt.

My first suggestion is that something like Cliff Dam, a water resource management structure generating new water, should dedicate a portion of the water to instream flow. I'm suggesting this approach. I really think, and I've heard both sides many times, that weather modification can increase the flow above that structure. Of course, it has to be included in the Forest Service plans. There's a lot of things that have to be gone through .... the whole EIS thing that you've got to do, the hurdles. But I say there's new water, water that we've never had before. On watershed management, I think you can get more water off the watershed. I don't think you have to tear down the riparian habitat along the streams. I think maybe some areas could be reserved, set aside. I think watershed management can increase water supplies and bring in new water. Some of the new water should be set aside for instream flow.

The second area I'd like to talk about as a post-condition is the restrictive discharge requirements for effluent-dominated streams or rivers. These requirements should be relaxed such that effluent can be discharged and you could have riparian habitat. When it becomes economically beneficial to do so, we'll just take the water out of the river and use it. It will not be there to form riparian habitat.

The third thing that I'd like to talk about in a post-condition, and this is really a wish, is that Arizona will not follow a state like Colorado and implement a State law for instream flow. In talking to my colleagues up in Colorado, they tell me that in the last two years it has been a mess with a capital "M". No new water has been created. They're trying to rearrange the allocation of water and all it has done is provide full employment for attorneys and hydrogeologists. It's not making any new water. I would say that the State of Arizona should not follow that strategy.

I guess you can see by now that I am the wild card. I'm a little different. I think the endangered species is Man. Described a little further, it's the Working Man who pays taxes. We're the ones that support everything. I would hope that we would not lose sight, that in order to be a working man, we have to have drinking water and water for other things. I would say also that we wouldn't put a fence around Arizona and say, "Hey, we're here, nobody else can come." I think we have a moral responsibility to leave the State open, allow people to come. We have a great environment, a great quality of life. I've seen it change a little bit in my 53 years. I think it's here. I think we should share it.

The second conclusion that I would like to leave with you is I hope there will be some middle ground and movement by both sides in the issue. Otherwise, I predict a rather bloody battleground on this issue.

PROBLEMS IN QUANTIFYING AUGMENTED FLOWS IN NATURAL CHANNELS

By

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In arid or semiarid areas, water-resource managers frequently dream of increasing the natural flows of streams so that at least enough water would be available to satisfy all the legal water rights. Cloud seeding or vegetative manipulation and other watershed treatments give promise of increased water yield that can breathe life into that resource manager's dream. Unfortunately, the old adage of "many a slip 'twixt the cup and the lip" comes into play. Although the amount of "new" water may be measured at the point it is developed, the water generally is needed elsewhere, and it is in the transmission of these augmenting flows that we encounter a series of problems. These problems all involve how much of the augmenting flow is available for use at the point of delivery. This report briefly describes the difficulties in accurately quantifying augmented flows transmitted in channels carrying natural flows.

The first problem is one of detection of change in the flow at the point of delivery. Measurement or detection of increases in streamflow can be accomplished at conventional streamflow-gaging stations. Problems in detecting changes in yield occur because of the differences in station-record accuracy, which depends, at least in part, on the nature of the control. For example, an artificial control (a V-notch weir) on Show Low Creek near Lakeside provides a stable and sensitive relation between the stage in the gage pool above the control and the discharge of the stream; therefore, records of streamflow are very accurate at this station. At the Black River near Point of Pines station, however, the control of the gaged pool is on a gravel bar. Although this bar is stable during normal flow conditions, it does change in high flows or floods, and, as a result, the records at that station are less accurate than those at Show Low Creek near Lakeside. At the Gila River at Calva gaging station, the low-flow channel is constantly shifting across a 700-foot-wide cross section and the control for the stage-discharge relation is the sand channel, which is also continuously scouring and filling. A railroad trestle crosses the river and is supported by seven sets of pilings. Over the course of time, almost every piling has been used to support a water-stage recorder. Recorders are now on two trestle supports, but despite such efforts, the record accuracy for this station is poor. The ability to detect changes in streamflow by using conventional stream gaging improves with increase in the stability of the control, the number and accuracy of discharge measurements, the sensitivity of the control, and the amount of reliable record of stage. Probably the most important of these is the stability of the control.

Another important aspect of the detection problem is the amount of augmenting flow relative to the amount of natural flow. This problem exists at Moenkopi Wash in the northern part of Arizona (fig. 1). In the early 1970's, a coal-mining operation was begun in the headwater area that covered only about 6 percent of the 1,650-square-mile drainage area above Tuba City. Concern was expressed that the mining operation would increase sediment yield to the detriment of the water users of Tuba City; therefore, a gaging station was established near Tuba City to measure water and sediment yield. After several years of data collection, the relation between annual water yield and annual sediment yield was poorly defined. The low degree of association between the variables was due to the natural variation of sediment yield and also, probably to a lesser degree, to the low accuracy of the records of water and sediment yield (fig. 2). The large scatter of annual data about the relation shown by the large standard deviation clearly demonstrates that only very large changes in sediment yield could be reliably detected at this gage. Thus, in addition to accuracy of station record in the detection of increase at the point of delivery, another important consideration is the percentage increase in the flow. In general, the more accurate the historic record and the greater the percent increase in flow, the more confident we can be in detecting and quantifying any increased yield.

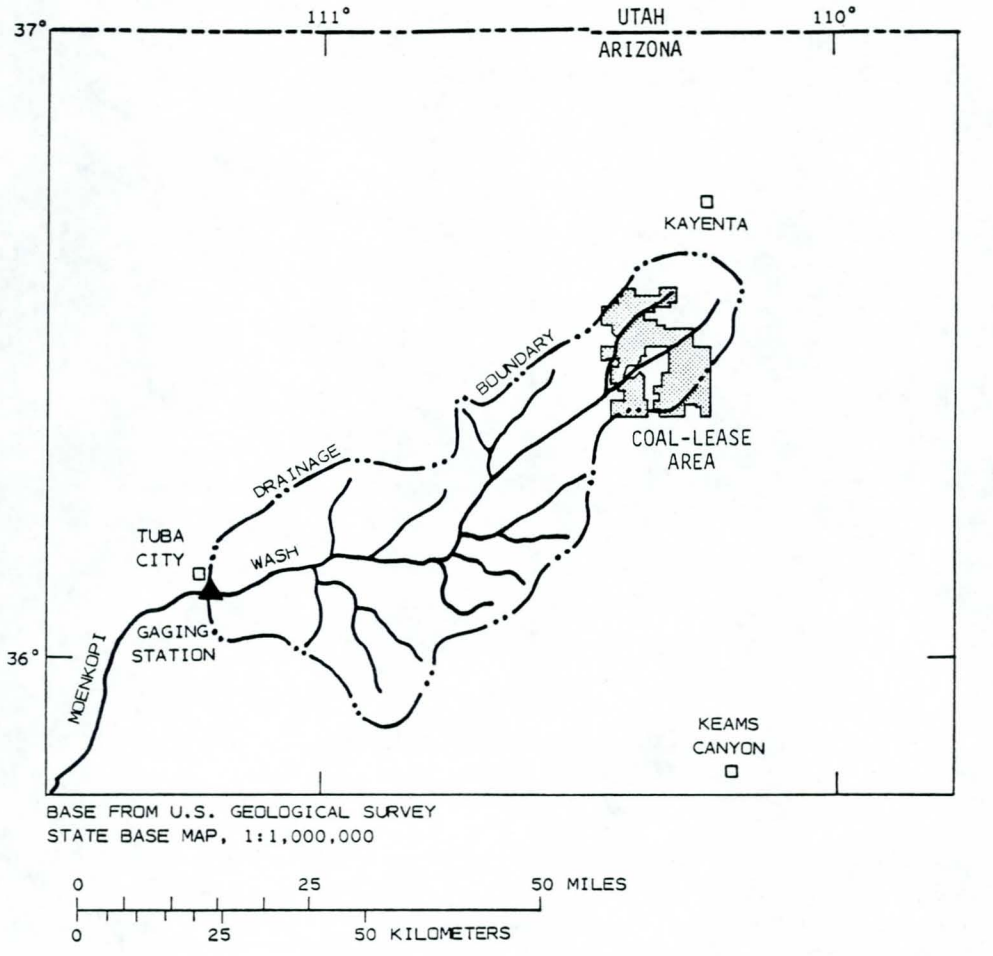
In those instances when an increase in yield at the point of delivery is detected and quantified, some technical problems still must be addressed and perhaps some institutional ones as well. For example, Anderson (1976) used existing data to evaluate the possible effects of increased evapotranspiration losses on increased yield. Selected areas in the Central highlands water province of Arizona where vegetative manipulation could achieve significant increases in yield were considered (fig. 3). Postulating such increases in yield, Anderson (1976) assumed that if more water were to be passed down the streams, increased evapotranspiration losses would be incurred owing to:

1. A greater water-surface area, especially for intermittent streams that would become perennial.

2. Shallower depths to ground water, which would increase evaporation from the capillary fringe.

3. The shallow ground water, which would encourage increased vegetation and increased transpiration.

Analyzing the streamflow records by regression analysis (fig. 4), Anderson (1976) found evidence of large losses to evapotranspiration along the streams. A potential evapotranspiration was computed for all the studied streams by comparing existing water-surface areas and vegetation densities with what would occur if yields were maximized and water-surface areas and vegetation densities increased to maximum probable levels. As shown in the following table, the Blue River, which is already perennial, would have only a modest increase in evapotranspiration losses. In contrast, the Hassayampa River, which is



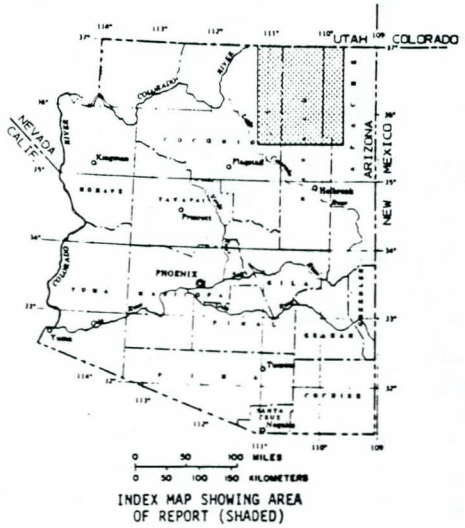


Figure 1.--Moenkopi Wash basin above Tuba City, Arizona.

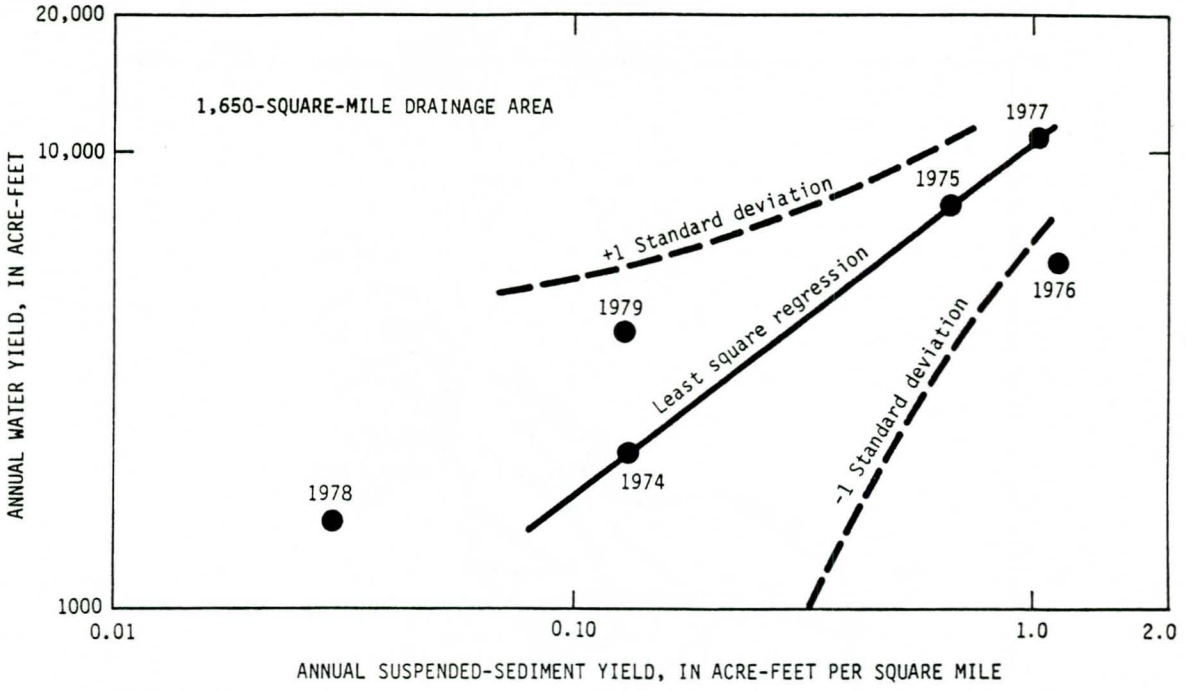


Figure 2.--Relations between annual yields of water and sediment for Moenkopi Wash at Tuba City.

intermittent, has a potential increase in evapotranspiration that could be four times as large as the existing evapotranspiration. Thus, if yield were to be increased on the Hassayampa, as much as 10,000 acre-feet of the increase could be lost to increased evapotranspiration.

Stream	Present evapotranspiration losses, in acre-feet	Potential evapotranspiration losses, in acre-feet
Blue River	1,300	1,500
San Francisco River	1,400	2,300
Salt River.....	4,500	8,400
Tonto Creek	8,700	22,000
Verde River.....	48,000	77,000
Agua Fria River.....	5,500	9,800
Hassayampa River	3,000	13,000

In this situation, an increase in yield is offset, at least in part, by an increase in losses along the stream. This phenomenon may not pose any particular problem as long as the losses are attributed to the augmenting flow. However, the losses, in fact, are shared between the natural streamflow and the augmenting flow, and the agency or individual that is responsible for the augmentation can make and defend the point that not all of the water lost was augmentation flow.

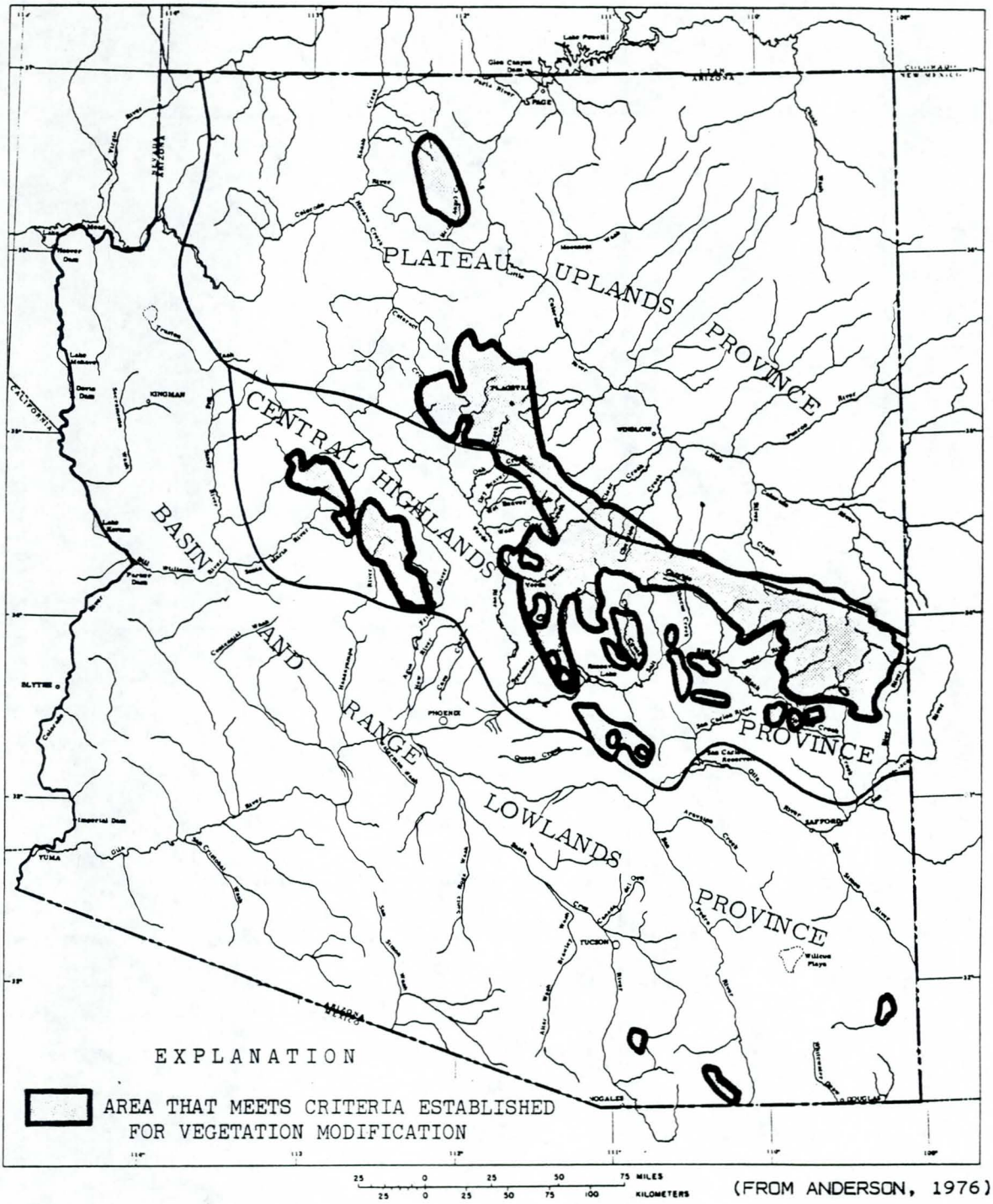


Figure 3.--Arizona's water provinces and areas where studies have shown a potential for increasing water yields through vegetative manipulation.

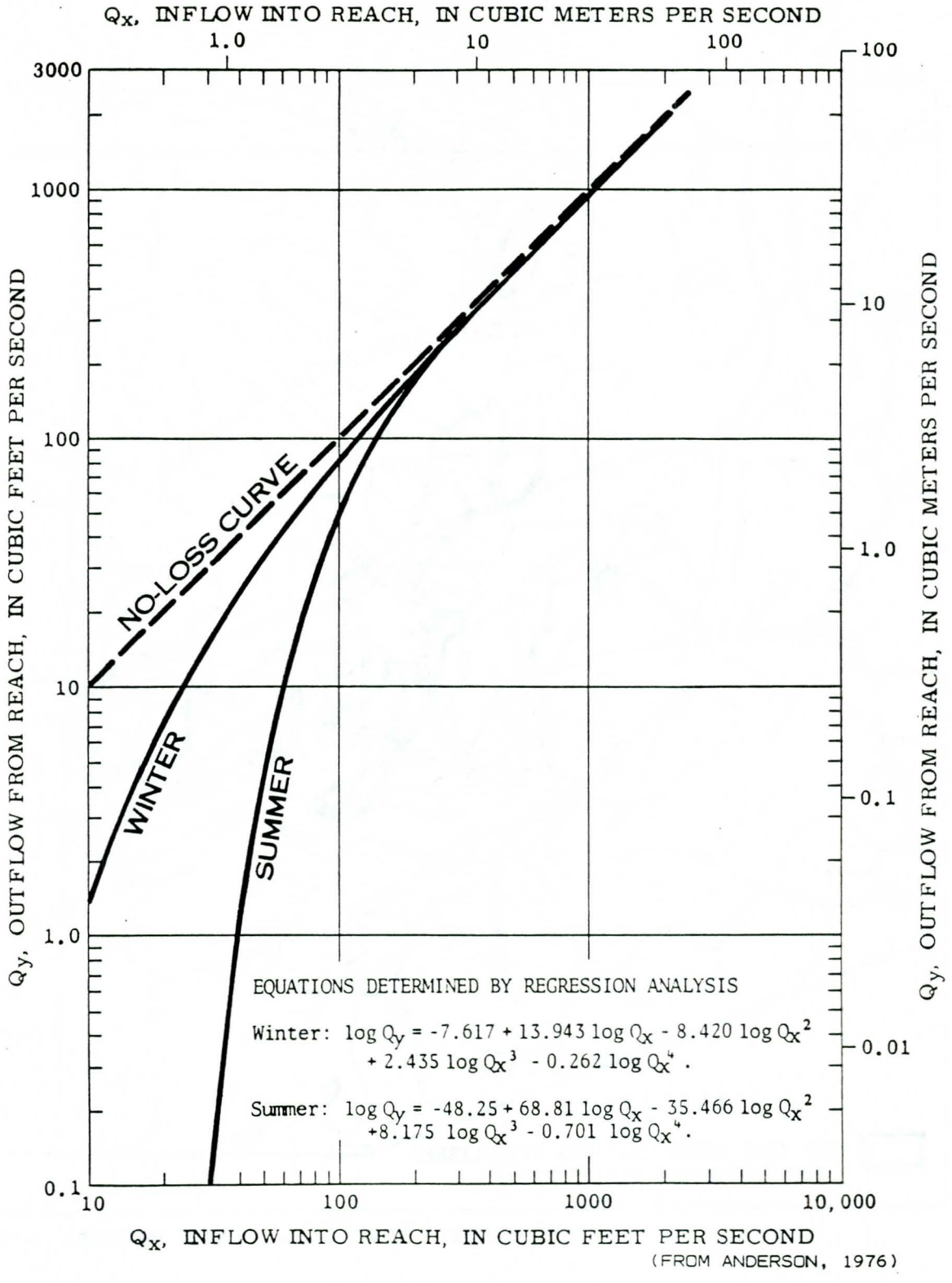


Figure 4.--Relation of evapotranspiration losses to flows in reaches between gaging stations.

An example of how a problem of this type can develop can be seen in the situation which developed between the Colville Indian tribe and a Caucasian farmer, both of whom felt they had rights to water flowing in a natural stream channel.

In the mid-1920's, a tract of land that is entirely within the Colville Indian Reservation in eastern Washington was sold from Indian ownership, and eventually a man named Walton acquired the land. (See Mac Nish, 1977.) Walton farmed the tract and irrigated his fields from a well near the north edge of his property. In addition, he diverted the flow of a small stream—No Name Creek—which rose from springs along a quarter-mile reach of the stream starting at the north boundary of his property (fig. 5). In the mid-1970's, the Colville Tribe developed irrigated agriculture north of Walton's land and supplied the irrigation water from a well field just north of Walton's well. In addition, the tribe pumped about 2 ft^3/s (cubic feet per second) from these wells into the stream channel of No Name Creek to provide water for a trout hatchery at the mouth of No Name Creek to the south of Walton's farm.

In May 1976, a controversy developed over the flow in No Name Creek. The Colville Tribe was pumping a little less than 2 ft^3/s into the stream above the Walton Farm. Half a mile downstream at Walton's point of diversion, about the same amount of water flowed in the stream, and the tribe claimed that water. Walton insisted that spring flow into the creek was still occurring and some of the water was rightfully his. On May 12 and 13, a series of flow measurements were made on No Name Creek at the points shown in figure 5. When only the measurements of flow at the north line and the diversion were considered, it appeared that there was an apparent loss of only 0.01 ft^3/s and the Colville Tribe might claim all was developed water or increased yield.

North line	1.82 ft^3/s
Diversion point	1.81 ft^3/s
"Effective" yield	1.81 ft^3/s (loss of 0.01 ft^3/s)
Developed water	1.81 ft^3/s
Natural flow	0

When the measurements made at intermediate points in the reach were considered, however, it was apparent that there were both gaining and losing reaches along the stream. If all gains were attributed to natural flow and losses were apportioned relative to the flows of the commingled water, the results show that the increased yield was only 1.46 ft^3/s and the natural flow of 0.35 ft^3/s belonged to Walton.

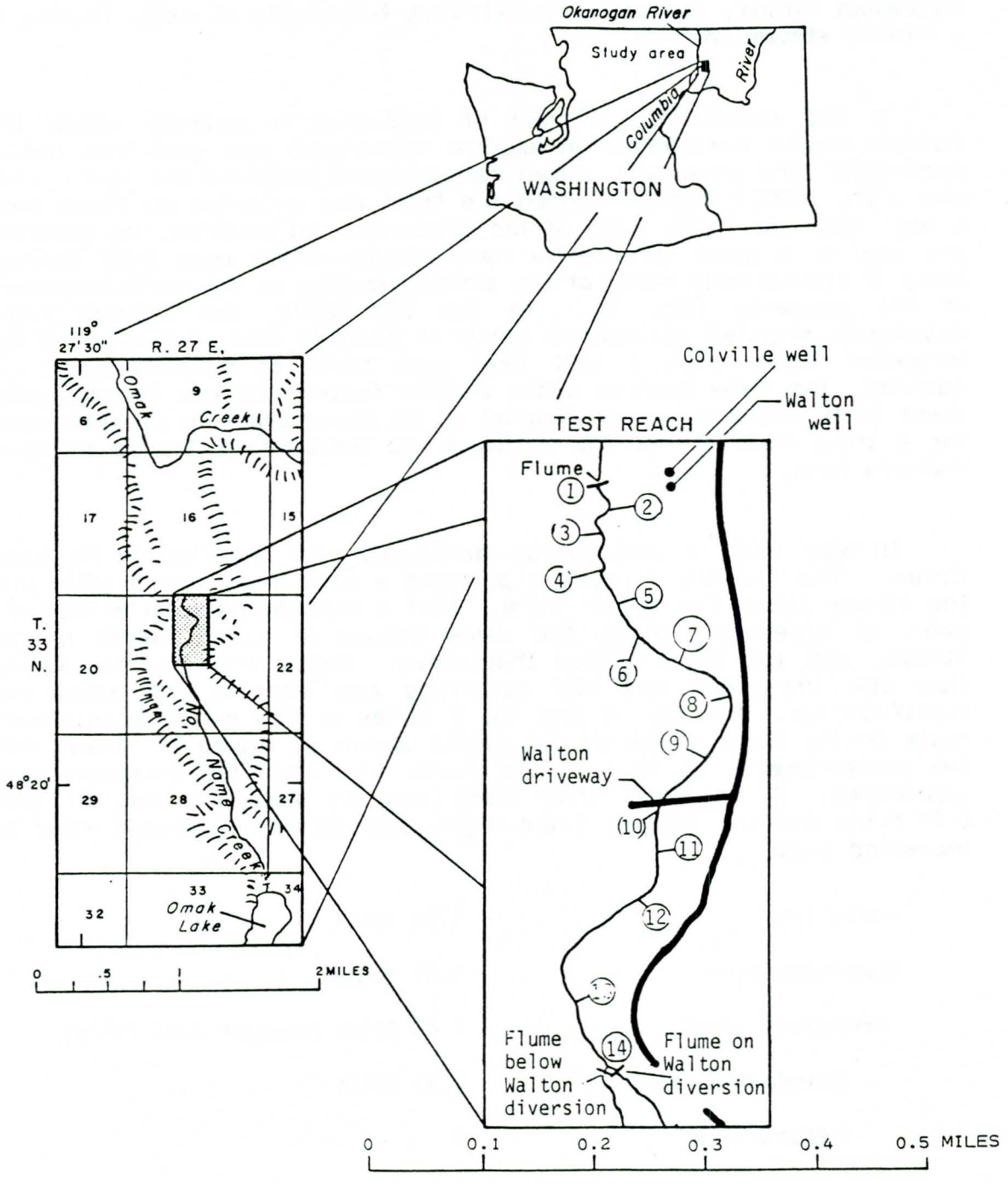


Figure 5.--No Name Creek valley and location of streamflow-measuring sites.

North line	1.82	
		Net loss of 0.14 ft^3/s
Site 4	1.68	
		Net gain of 0.40 ft^3/s
Site 11	2.08	
		Net loss of 0.27 ft^3/s
Diversion	1.81	
Developed water	1.46	"Effective" yield
Natural flow	.35	

The situation was even more complex because of the hydrology in the area of the springs (fig. 6). Both the Colville Tribe's and Walton's wells were pumping water from a semiconfined sand and gravel aquifer overlain by a 12- to 18-foot-thick glacial lake deposit composed of silt, very fine sand, and clay-size particles of ground-up rock. The pumping stress created a cone of depression that lowered the head in the sand and gravel to a point below the stream in the reach of the stream where the springs flowed from lacustrine sediments. The springs continued to flow because they were fed by the water-table aquifer in the lake deposit that in turn was being recharged by precipitation and irrigation water applied by Walton and the Colville Tribe. Thus, in the reach of the stream near Walton's north boundary, the stream was gaining water from springs that drain the lacustrine deposit. At the same time, water was leaking from the stream-channel deposits into the underlying sand and gravel aquifer.

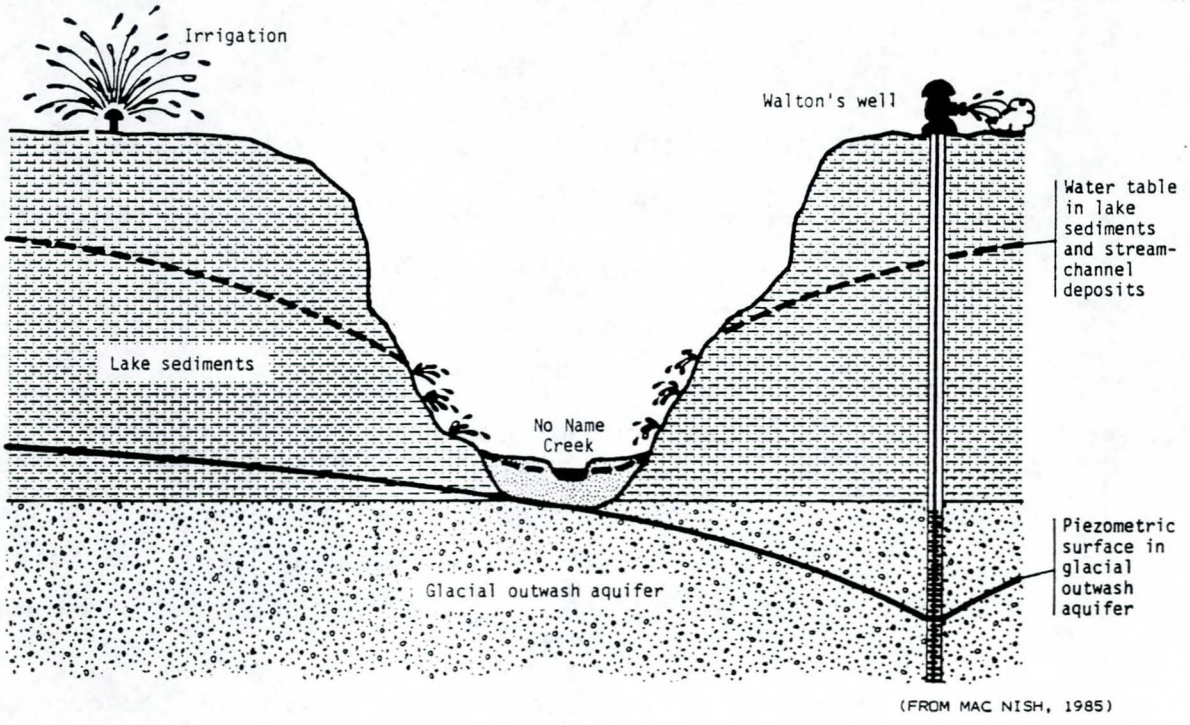


Figure 6.--Schematic diagram of head relations near site 2.

Mac Nish (1977, 1985), showed that by using two equations, one for water flux within a reach, and one for a tracer flux within the same reach, the gains and losses in streamflow through the reach could be quantified. For a reach between two of the points where flow was measured along the creek, an equation for the flow of water could be constructed:

$$Q_d = Q_u + Q_i - Q_o, \quad (1)$$

where

Q_d is the flow at the downstream end of the reach,

Q_u is the flow at the upstream end of the reach,

Q_i is the gain from springs, and

Q_o is the loss to the underlying sand and gravel aquifer.

The quantities Q_d and Q_u can be measured, but because Q_i and Q_o cannot, another equation containing the same two unknowns is required. If another flux related to discharge—such as chloride—is considered, the necessary equation can be constructed:

$$Q_d C_d = Q_u C_u + Q_i C_i - Q_o C_o, \quad (2)$$

where

C_d is the concentration of chloride at the downstream site,

C_u is the concentration of chloride at the upstream site,

C_i is the concentration of chloride in the gains along reach, and

C_o is the concentration of chloride in losses along reach.

The products of QC in the equation represents the chloride flux at those points. As before, the C_d and C_u in the stream can be measured directly, and C_o can be approximated as being the average of C_d and C_u. The value of C_i may be estimated from the background concentration of chloride measured in samples from the stream and from springs that could be sampled.

By use of the stream data collected on May 13 and the background chloride data from May 12, equations 1 and 2 were applied to each reach above site 9. The results showed:

Sites	Gain	Loss	Net change	Natural flow	Developed water	Total flow
1					1.82	1.82
	----	-----	-0.09			
2					1.73	1.73
	0.13	-0.18	-.05			
5				0.12	1.56	1.68
	.14	-.03	.11			
7				.26	1.53	1.79
	.28	-.02	.26			
9				.53	1.52	2.05
			.03			
12				.56	1.52	2.08
			-.27			
14				.49	1.32	1.81

Note: All discharge shown in cfs. 1 cfs = 0.028 m^3/s.

In all reaches, the gains were attributed to natural inflow and losses were proportionally distributed to both components.

SUMMARY

Increases in basin yield as reflected in streamflow generally are measured by conventional means. Detecting increases in yield presents some problems. Generally, the longer and more accurate the existing record of natural yield and the larger the percentage increase in yield, the less time it takes for the increases in yield to be quantified with confidence. Problems are encountered in evaluating "effective" increases in yield where the increased yield is commingled with natural flows for transmission to a remote point of use. Some complex but tractable hydrologic problems are involved in determining which component of the commingled flow is which, but in the case of fully appropriated natural flows, there may be even more complicated problems in determining whose water is whose.

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Survey of Instream Flow Methods

Paul J. Barrett [1/] and Martin D. Jakle [2/]

Abstract

A survey of existing methods used to recommend instream flow appropriations is presented. Methods are divided into three groups: professional estimation, hydrographic methods and hydraulic methods. Hydrographic methods rely on the existing stream flow data and are illustrated by data from the Verde River in central Arizona. Hydraulic methods rely on mathematical models of the stream flow at different points and are discussed. Recommendations for selecting the appropriate method to be used under different circumstances are presented.

Introduction

The issue of instream flow appropriation in Arizona has received much attention in recent years. The Arizona Nature Conservancy has been granted instream flow appropriations for O'Donnell and Ramsey Creeks by the Arizona Department of Water Resources (ADWR). Subsequently, many other applications were received. In an effort to objectively determine the validity of these applications, ADWR convened an interagency task force to evaluate the issue of instream flow. This paper is an attempt to briefly summarize some of the existing methodologies for determining instream flows and present information which will help researchers and resource managers to determine techniques most applicable to their circumstances.

The methods for quantifying instream needs fall into three categories: professional estimation, hydrographic methods, and hydraulic methods. Professional estimation is the most basic of all methods and is incorporated into all methods to some degree. It is simply an estimate based on the professional judgment of a biologist familiar with the system in question. Although qualitative, if knowledgeable individuals are involved, this method may produce an accurate answer. Unfortunately, several local experts may yie'd conflicting estimations. Furthermore, the lack of quantification may lead, incorrectly, to the conclusion that the method is unreliable. The reliability of this method rests solely with the biological acumen of the experts and their familiarity with the species and area of interest.

Hydrographic methods are based on a hydrograph of the stream's flow. Set percentages of this flow, for example, 60 percent of the mean annual flow are reserved for instream flow uses. Perhaps the best known method in this group is the Tennant Method and its subsequent modifications.

Hydraulic methods use data which are gathered at specific stream locations. Measurements such as stream depth, velocity, width, and water surface elevation are taken. A mathematical formula is then applied to these data and the stream is modeled at different flows. Biological data such as water velocity necessary for spawning is married with the hydraulic data and changes in habitat (primarily fish habitat) are determined for different flows. The best known methodology in this group is the Instream Flow Incremental Methodology (IFIM) and it too has several variations.

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Hydrographic Methods

Tennant Method

One of the first techniques developed and one of the most widely used is the Tennant or Montana Method (Tennant, 1976). Between 1964 and 1974, Donald Tennant examined 11 streams in Nebraska, Wyoming and Montana. These streams represented a variety of stream morphologies and he documented physical, biological and chemical changes in the streams over the range of their annual flow fluctuations. Tennant concluded that changes in aquatic habitats are extremely similar among streams having similar annual flow regimes. He then surmised that 10 percent of the mean annual flow (MAF) would sustain short-term survival for most fish species. To sustain good survival habitat, 30 percent of the MAF was needed. Sixty percent of MAF provided excellent habitat. Tennant then proposed a range of percentages of the MAF regime to maintain desired flow conditions on a seasonal basis (Table 1).

Health of Habitat	Percent of Mean Annual Flow (MAF) October to March	April to September
Flushing or Maximum	200% MAF	
Optimum	60% to 100% MAF	
Outstanding	40%	60%
Excellent	30%	50%
Good	20%	40%
Fair	10%	30%
Poor	10%	10%
Severe Degradation	less than 10%	

Table 1. Instream flows necessary to maintain habitats, from Tennant (1976).

To use the Tennant method, the MAF for a stream is determined. These data can usually be calculated from the USGS data using the period of record for the stream. Tennant recommends that the stream be visited to observe, photograph, sample and study the flow regimes at approximately 10, 30, and 60 percent of the MAF. The investigator can then adjust the recommended flows where necessary. The Tennant Method has the advantage of being fast and easy to accomplish if stream flow data exist for the stream in question. However, this method relies heavily on the professional judgement of the investigator. As with most methods, stream flow recommendations are instantaneous flows, which means that stream flows should meet or exceed the recommended flow at all times.

Modified Tennant Method

Several modifications to Tennant's method have been proposed. The application of the Tennant Method in its strictest form will result in unprecedented low flows (only subsurface flow in extreme cases) in streams with extremely constant base flow conditions throughout the year. In 1976 Tennant suggested adding the words "or natural stream flows if less than recommended minimum" after each recommendation. Additionally, he recommended 30 percent of the MAF as the "minimum flow" to protect aquatic resources, although flows as low as 10 percent of the MAF could be used as the absolute minimum, e.g., short term survival flows. He also suggested reconstructed virgin flows should be used to determine MAF.

Bayha (1978) also suggested that spring flushing flows may be required to clean spawning gravels, recharge wetlands and aid in fish spawning migrations in some areas. In locations where this may be an issue, it was recommended that 100 percent of the average annual discharge during the normal spring runoff be maintained.

Hilgert (1982) applied Tennant's percentages to streams in the Sandhills region of Nebraska. Instead of using the average annual flow, he used an estimate of base flow for making instream flow recommendations. Base flow was estimated by using the median flows during the dry season, e.g., November, December, and January. This method would remove a fixed percentage of water throughout the year and high flow months would be treated the same as low flow months.

Great Plains Method

The Great Plains Method or Modified Montana Method is another variation of the Tennant Method and was proposed in 1974 by a group working in the Northern Great Plains Resource Program (Bayha, 1978). It was based on the premise that water presently flowing in a river represents flows supporting present levels of aquatic or related resources, i.e., the biota of the river is in equilibrium. They suggested that for each month, the flows be ranked from highest to lowest. The upper and lower 15 percent were then eliminated. A flow duration curve was then constructed using the remaining data. An instream flow recommendation of a 90 percent exceedence flow (i.e., 90 percent of the time the flow will be greater than the stated value) is recommended for each month. These recommendations can then be adjusted for tributary inflow to and diversion out flow from the waterway in question if the stream gage is not ideally located. Finally, these values can also be adjusted for the specific fishery resources and specific species life stages in the area, e.g., blue ribbon trout spawning areas.

This method has the advantage of being fairly fast and easy and takes into account the stream's annual cycle in that it is based on monthly data. It may be somewhat subjective in that it makes general assumptions about the amount of stream flow necessary for a healthy aquatic community.

Figures 1 and 2 illustrate the results of applying these hydrographic methods to the Verde River in central Arizona. Two USGS gages were used. Figure 1 presents the data generated for USGS gage 5037, Verde River at Paulden. Figure 2 presents similar data generated for USGS gate 5085, Verde River at Tangle Creek. Although these gages are located on the same river, the annual hydrograph of the two gages differ greatly. Paulden gage is located near the headwaters of the system. It has an annual median discharge of 24.8 cubic feet per second (cfs) and is characterized by a relatively stable flow, although occasional large flushing flows do occur. The Tangle Creek gage, however, has an annual median flow of 246.7 and is subjected to much more variation in its seasonal flow regime.

After examining figures 1 and 2, it is obvious that the Great Plains Method better reflects the natural variation in both hydrographs. Intuitively, this seems desirable to us, but to our knowledge, no rigorous comparison of these methods have been accomplished.

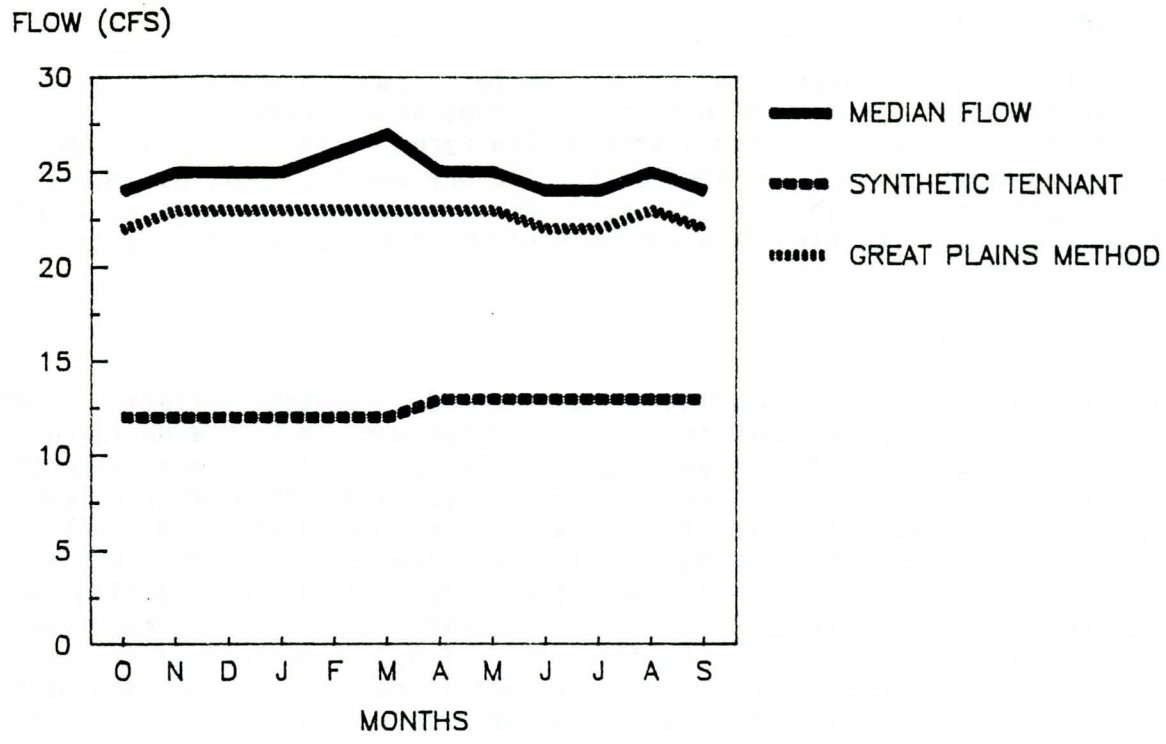

Figure 1. Flow recommendations based on stream flow data from USGS gage 5037, Verde River at Paulden in central Arizona. Recommendations were generated by using two hydrographic methods.

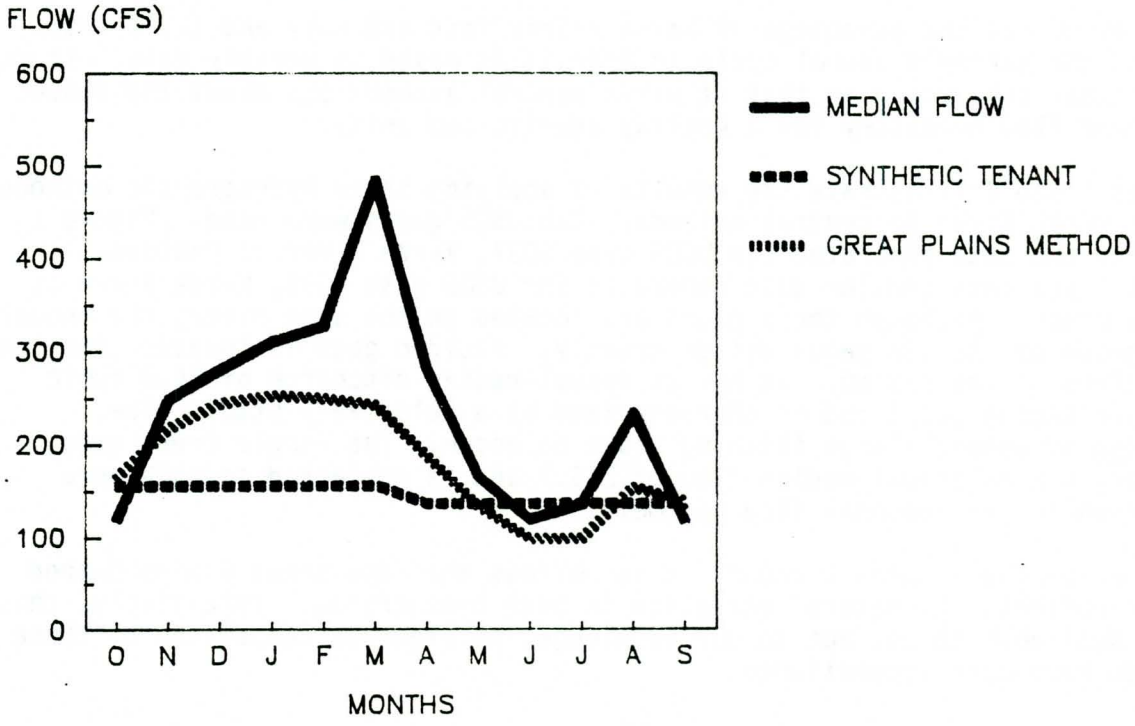

Figure 2. Flow recommendations based on stream flow data from USGS gage 5085, Verde River at Tangle Creek in central Arizona. Recommendations were generated by using two hydrographic methods.

Hydraulic Methods

Wetted Perimeter

The most basic of the hydraulic methods is the Wetted Perimeter Method. There are several variations of the method, but all must assume that maintenance of suitable conditions over riffles will maintain suitable conditions in other areas as well and that the wetted perimeter (figure 3) is closely related to fish habitat.

In all variations a critical cross section over a riffle is established. Next, the wetted perimeter of the cross section is calculated at various flows either through actual physical measurements at these flows, or through hydraulic simulation based on one set of physical measurements then using a computer model such as IFG1 (Milhous 1978; Annear and Conder 1984). Wetted perimeter versus discharge is then plotted. The plot is examined and an inflection point in the curve where small decreases in discharge yield large decreases in wetted perimeter is the recommended instream flow (figure 4).

In addition to the above-mentioned assumptions, this method is based on the subjective judgement of the investigator reviewing the wetted perimeter versus discharge curves. Also, several inflection points may appear on a single curve complicating the flow recommendation decision. Conversely, there may be no distinct inflection point and the decision becomes more subjective.

Usable Width Method

The Usable Width Method builds on the Wetted Perimeter Method. This method was developed for salmonids, but different activities can be evaluated for other species of interest. It was one of the first methods which incorporated biological parameters directly into the analysis (Thompson, 1972). Also known as the Oregon Method, it was originally developed for passage analysis in the Northwest (Bovee pers. comm.), but eventually was expanded to include spawning, rearing and incubation as well.

Criteria were developed for each species, usually using depth and velocity as variables, e.g., for chinook salmon, minimum depth (D_{min}) = 0.8 ft, and maximum velocity (Vmax) = 8 ft/sec. Next a single cross section was measured at multiple discharges or modeled at one discharge similar to the wetted perimeter method. Data were gathered and criteria established for the different biological activities the investigators thought were important such as passage, spawning, incubation, migration and rearing. Shallow bars were considered the limiting factor for passage. Single transects were placed across the shallowest portion of one or several bars. The percent of the width of the stream meeting a previously determined depth criteria was then calculated. A minimum flow recommendation can be made which will allow passage of adult fish over shallow areas. A similar method is used for spawning with transects being placed across spawning bars. The recommended discharge is that which creates suitable flow conditions over 80 percent of the bar during spawning season.

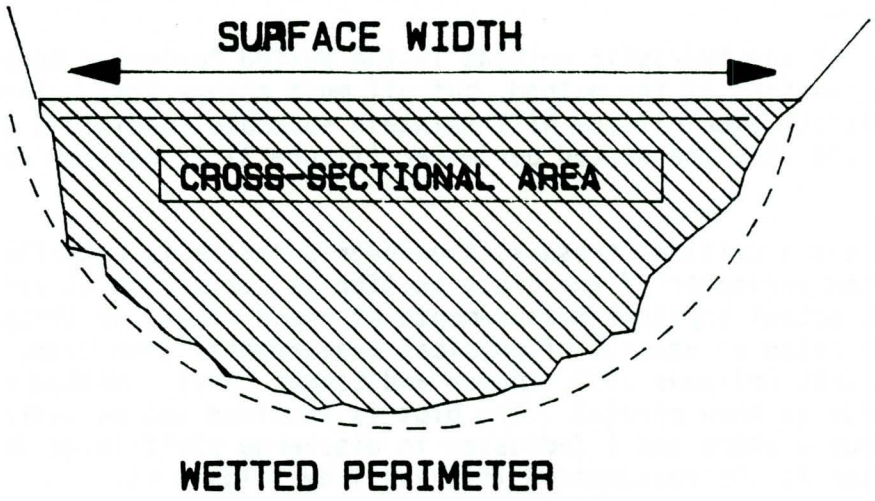

Figure 3. View of a stream in cross section showing the different measurements used in the Wetted Perimeter Method.

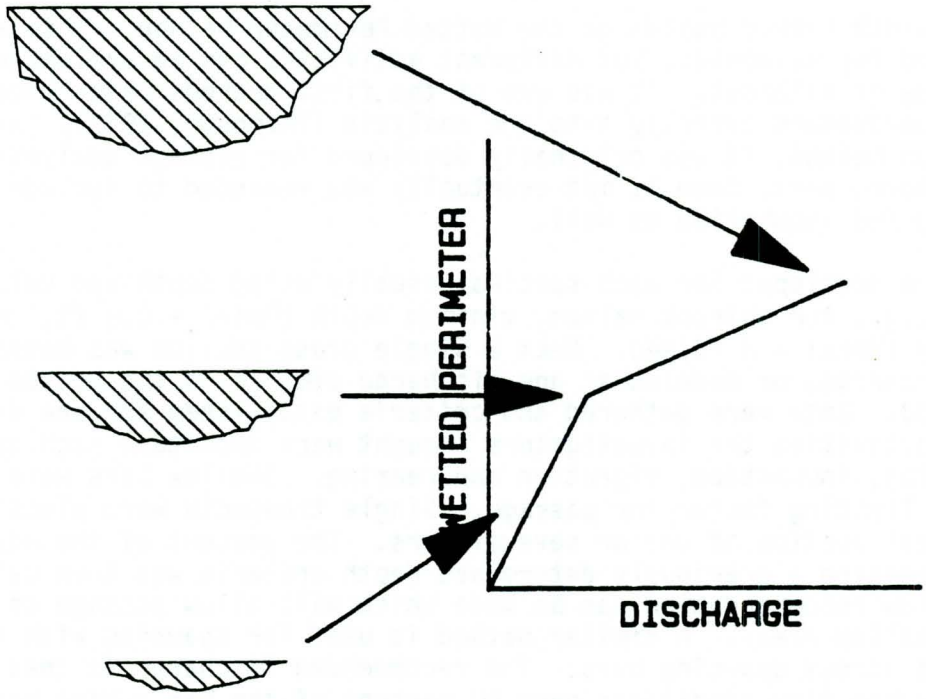

Figure 4. Plot of wetted perimeter versus discharge used to determine an inflection point in the graphed line.

are repeated for various flows until the minimum flow which will support a target species is determined. Since all transects are tied into a single master reference point, only a single set of stream measurements must be taken.

IFG1

IFG1 is a modified version of the R2-Cross computer program and was developed by the Cooperative Instream Flow Group (recently reorganized as the Aquatics Systems Branch of the National Ecology Center) of the U.S. Fish and Wildlife Service (Bovee and Milhous, 1978; Hilgert 1982). The primary difference between the two is that IFG1 will also predict widths of streams having specific depths in addition to the parameters predicted by the original R2-Cross program.

The Hunter Creek Method (Boaze and Fifer, 1977) is a further refinement of the R-2 Cross Method. Several transects were selected for each study site, each representing at least one habitat type necessary for trout production, food production, cover, spawning areas and fish passage. Hydraulic measurements were made at each transect at seven different flows negating the need for computer simulation of flows, but greatly increasing the amount of fieldwork. Habitat criteria for water velocity, depth, and wetted perimeter were developed from a literature search and discussions with species experts. The hydraulic data were then used to calculate the value of each habitat variable at each of seven different flows. The subsequent recommended flow was the lowest of the seven flows which met at least two of the criteria as previously established.

Both Jesperson (1979, 1980) and Wesche et al. (1977) used similar techniques on many of the same streams in southwestern Wyoming. Essentially, it was the R2-Cross Method with multiple transects at each study site. The R-2 Cross computer program was used to simulate hydraulic characteristics at different stages.

Region 4 of the USFS developed a technique based on stream survey methods and cross-channel transects (Tew et. al., 1977). Five transects are placed across predetermined critical reaches at 50 foot intervals. The transect tape is tightly stretched across the stream and hydraulic measurements taken. At the same time a measure of flow is recorded and this is termed the index flow. All other flow simulations are related to this index flow. Average velocity, depth, width, area, and wetted perimeter are calculated and used as a base for comparing the amount of habitat at different flows.

A range of different flows are simulated using Manning's equation. The habitat available, i.e., hydraulic measurements, at the index flow is arbitrarily given a value of 100 percent and other a plot of these values versus discharge is made.

Weshe and Rechard (1980) state that the index flow measurements should be made during the lowest possible summer flows. Also, the R-2 Cross computer program can be substituted for the Manning's equation and used to calculate the predicted hydraulic parameters at additional flows. A major drawback of this technique is that the index flow is rather arbitrary. No site specific biological data were used to determine what the index flow should be.

Stream transects were not used to develop flow recommendations for rearing fish. Instead, the stream was studied during several flows and it was estimated which flows would be suitable based on the following six criteria:

1. Adequate depth over riffles.
2. Riffle/pool ratio near 50:50.
3. Approximately 60 percent of the riffle area covered by flow.
4. Riffle velocities 1.0 to 1.5 feet per second (fps).
5. Pool velocities 0.3 to 0.8 fps.
6. Most stream cover available for shelter for fish.

The incubation requirements were initially an estimate of the flow which would cover gravel areas used for spawning and create an intra-gravel environment conductive to successful egg incubation and fry emergence. Weshe and Rechard (1980) state this generally amounts to about 2/3 of the spawning flow. In 1974, Thompson related the amount of dissolved oxygen available at different flows to the success of salmon eggs making flow quantifications for this life stage less subjective.

After flow recommendations are determined for each biological activity for the species of interest, a chart of the life history of each species and the recommended flow for each life stage is compiled. The flow recommended for any two week period is the highest flow required to accommodate any of the biological activities which occur during that period.

R-2 Cross Method

This method was the basis for an entire family of instream flow techniques, several of which are known by multiple names. They include the Single Cross-Section, Colorado, Critical Area, and Sag-Tape Methods.

The original procedure was developed by the U.S. Forest Service, Region-2 (Silvey, 1976). In this procedure, the entire river is broken up into study segments based on biological, hydrological, water quality or other parameters of concern, e.g., an important sports fishery or an area of great flow accretion. Single transects are then placed at critical or representative study sites. If critical sites are chosen, the investigator assumes that flows must be maintained at these critical sites to protect the fishery. If representative sites are selected, it is assumed that the transects will act as indicators for the entire stream segment. Usually the shallowest area of the shallowest riffle is used and considered a critical site for fishery considerations. All sites are marked and photographed.

Stakes are placed in the ground at both ends of the transects and leveled with each other using a string-line level or Abney level. A steel tape or chain with a known weight/foot is stretched from the top of one cross section stake to the other using a tape clamp and spring scale. Next, measurements from the tape to ground surface or channel bottom are taken to construct a bottom profile and velocities are recorded at intervals along the tape. A master reference point upstream is established and discharge (CFS) is taken to determine the stage.

These data are then inputted into the R-2 Cross or similar computer program which calculates parameters listed in Figure 3. The program calculates the portion of the stream which meets or exceeds previously established depth requirements for the species of interest for fishery purposes. Predictions

Instream Flow Incremental Methodology

Instream Flow Incremental Methodology (IFIM) is the standard methodology used by the FWS and was developed by the Cooperative Instream Flow Service Group in Fort Collins, Colorado. It provides information on the effects of a variety of flow regimes, and as such, can be used for negotiations.

There are several aspects to the methodology. Biological criteria need to be developed for the species of interest. Biological criteria were developed for several of the previous methods, but it is a cornerstone of this method and emphasis is placed on collecting biological data from the stream to be modeled. Biological data are incorporated into an electivity curve, a two dimensional plot representing the relative suitability of a variable (depth (D), velocity (V), substrate (S), or cover (C)) for a fish life stage (Figure 5). These curves which are based on field data may be either utilization (type 2) curves, or preference (type 3) curves. The former are based on where the species is most likely to be found under prevailing conditions and the latter are an estimation of where the organism would be found were all possible conditions available. A separate curve is created for each life stage of each target species: adult, juvenile, larval, and spawning. For a more complete explanation of how these curves are created and used, please refer to Nelson, 1984.

Another major aspect of IFIM is its hydraulic simulation capabilities. It will predict the values of hydraulic parameters for a range of flows.

In the past, several different routines were used for the hydraulic simulation depending on the physical structure of the stream in question. It is now recommended that a single set of IFG4 measurements be used to calculate the velocity distribution across a channel. A stage-discharge relationship is then established using one of three methods: a rating curve, a step-back order simulation or normal depth model.

The stage-discharge relationship is determined in one of three ways. First, the log-log linear relationship between water surface elevation (WSL) and velocity may be determined. This is done with at least three sets of discharge and WSL measurements, i.e., the traditional IFG4 procedure. Second, a step-back order simulation uses Bernoulli's and Manning's equations to establish the stage-discharge relationship, e.g., Water Surface Profile (WSP) or Hydraulic Engineering Center (HEC) computer programs. Lastly, a normal depth model is produced using MANSQ or R2 Cross computer programs.

These are all recent innovations in IFIM and have not been widely published. It goes under the name of the Combined Method or IFG4A. When using any of these simulations, it is important that the investigators calibrating the model understand the theory behind the simulations.

IFIM can incorporate seasonal flows, and flow recommendations can be made which take into account both the seasonal flows and requirements of the different species' life stages. This can be accomplished by developing a habitat time series. Monthly mean or median flows are entered into a computer program and habitat values (WUA) are given for each species' life stage, for each month and normal or baseline conditions are established. Goals can then be established, for example, determining a flow which retains the median amount of WUA for spawning during the spawning seasons and this same amount of adult habitat during the rest of the year for rainbow trout, and flows which meet these goals determined.

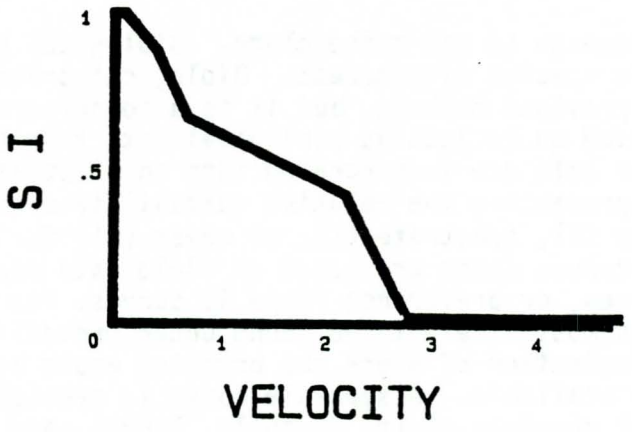

Figure 5. A habitat preference curve describing habitat suitability of different velocities for adult Sonora sucker (Catostomus insignis).

Discussion

All methods evaluated have strengths and weaknesses. A single technique which would fulfill the needs of every situation has yet to be developed. It is important to select a technique which will yield a recommendation based on the needs and resources available. Figure 6 is offered as an aid. It presents our qualitative assessment of the relative costs and benefits of each method. When using this figure, three factors may need clarification.

To our knowledge, IFIM has never been defeated in court. This does not guarantee its acceptance in the future, nor will it rescue a poorly designed or executed study. It does, however, indicate a strong legal history. We are not as familiar with the legal background of other techniques. Obviously, the professional estimation is strongly dependent on the reputation of the experts involved. The hydrographic and hydraulic methods have been used with success in other parts of the country.

Secondly, the biological reliability of the methods (i.e., will they produce recommendations sufficient to protect instream values), is a very controversial area. All methods have been criticized to some extent, and IFIM is presently under extensive scrutiny by the biological community. We feel confident that IFIM can yield reliable estimates in some circumstances. It is, however, a very complex technique and requires a large commitment of time, money, and technical expertise as compared to other methods. The time commitment is not only required by the actual physical measurements and data manipulation, but must be manifested in an effort to truly understand the assumptions, development, and limitations of IFIM.

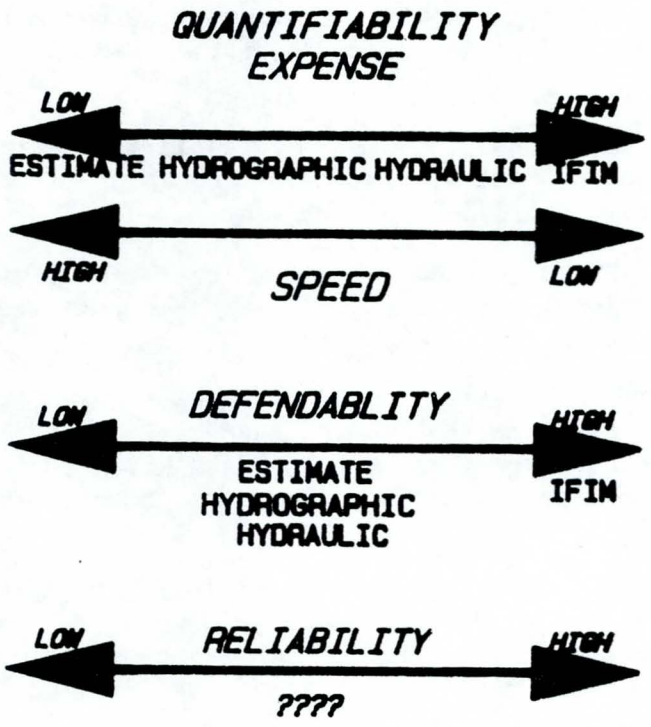

Figure 6. Summary of the strengths and weaknesses of the different instream flow methodologies.

Finally, unlike most other methods, IFIM by its very nature allows for negotiation. Other methods usually result in a single "minimum" flow below which diversions should be discontinued. If agreement cannot be reached on this minimum flow, litigation may be the only alternative. IFIM allows a wide variety of scenarios to be developed and evaluated. Subsequently, differing mitigation programs or withdrawal schedules can be determined depending on the exact size and nature of the withdrawals.

This paper by no means evaluates all existing techniques; instead, we hoped to present an overview of what we feel are the major groups of methods available and illustrate the more common methods from each. With this in mind and the cautions stated above, we believe this will help guide those individuals selecting an instream flow methodology.

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INSTREAM FLOWS--ECONOMIC VALUES AND POLICY ALTERNATIVES

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INSTREAM FLOWS--ECONOMIC VALUES AND POLICY ALTERNATIVES

Policymakers and the public's interest in instream flows has been stimulated by a number of forces over the last several decades. First, the West is rapidly becoming urbanized and urban populations demand boating, fishing and other outdoor recreation opportunities that rely on adequate stream and lake levels. Second, as diversions of water for off-stream irrigation, industrial and residential deliveries have increased, flow levels on many stream systems have decreased--sometimes to the detriment of instream water uses. Finally, there is increased appreciation by many westerners of the intrinsic and aesthetic value of free flowing water and of its economic value in enhancing recreation and wildlife habitat, thus contributing to the western tourism industry. This paper summarizes recent studies on instream flow values in the Southwest, reviews six southwestern states' policies on instream flow protection, discusses the relationship between the water marketing phenomenon and instream flow protection, and concludes with suggestions on a policy approach for Arizona.

Instream Flows--What Are They "Worth"?

Water-based recreation is an important part of many Southwesterners' leisure activities and water-related recreation opportunities draw visitors and tourism dollars to the Southwest. Since there is little direct market evidence on willingness to pay for recreational opportunities, a variety of nonmarket valuation approaches have been applied to estimate the value of outdoor recreation.(1) A few studies which focus on the contribution of water resources to recreation values in the Southwest are reviewed here.

Daubert and Young (2) examined the contribution of stream flows to recreation benefits on Colorado's Cache la Poudre River. They found the value of an additional acre-foot of flow for fishing to be $21 during low flow periods and the value of an additional acre-foot for shoreline recreation to be $15 during low river flows. Values for an additional unit of flow dropped to zero at higher flow levels suggesting that minimum flow maintenance is of value to recreationists rather than additional increments to already adequate flows. Walsh et al. (3) investigated flow values at nine sites along Colorado mountain streams and found that flow levels of 35 percent of maximum stream flow were optimal for recreation. The value of an additional acre foot of flow beyond the 35 percent flow level was estimated to be $21 per acre-foot for fishing, $5 for kayaking and $4 for rafting. Walsh, Aukerman and Milton (4) estimate that leaving water in high mountain Colorado reservoirs for an additional two weeks in August is worth $48 per acre-foot in additional recreation benefits during that peak recreation period. Amirfathi et al.(5), analyzing recreation on a river in northern Utah, found that the value of additional flows is zero until flows dropped to 50 percent of peak levels and that the value of additional flows reached a maximum of $80 per acre-foot when flows were 20-25 percent of peak levels. Ward (6) examined the relationship between stream flow levels, recreation use levels and travel costs incurred by recreationists on New Mexico's Rio Chama to infer a value of $16 to $27 per acre-foot of reservoir releases in the summer recreation season, assuming optimal augmentation of streamflows during low flow periods. Consistent with other studies, Ward found that marginal values fall dramatically for high flow periods and when stored water is

available to augment natural flow levels. These results suggest a significant economic payoff in augmenting stream flows in low flow years, even though augmentation would reduce water availability for other basin uses.

Loomis (7) provides an overview of the various methods that have been applied to measure the economic value of instream flows, citing studies relying on the travel cost method and on contingent evaluation. He argues convincingly, based on the studies cited, that dollar values of instream flows can be measured so as to be comparable to the value of water in offstream uses such as irrigation.

Few studies have estimated the value of improved stream flows for fish and wildlife habitat in the southwestern states. One study places the average value of stream flow in California's Trinity River at $31 per acre-foot for fish hatchery operations.(8) Water to facilitate salmon spawning in California's Trinity River has been valued at $53 per acre-foot.(9)

The wildlife valuation literature recognizes many different values associated with wildlife and fish species. These include "user" values for recreational and commercial hunting and fishing, wildlife sightings (birdwatching, for instance) and photography and non-user values. Non-user values are difficult to measure but are of several types. Those associated with preserving a species and its habitat so that one has the option to enjoy them in the future are termed "option values". Willingness to pay for preservation so that one's heirs can benefit is termed "bequest value", and values generated simply by knowing a species or a unique site will continue to exist are termed "existence values".(10) Non-user values are not associated with an

actual visit to wildlife habitat and are particularly difficult to estimate. Non-user values apply not only to wildlife species whose survival may be linked to water resources but also to natural environments, such as wilderness areas, whose aesthetic characteristics are dependent on water. The little empirical evidence that exists suggests non-user values can be sizable, especially for unique sites.(11) Recognizing that potentially significant but hard-to-measure non-user values are associated with water in lakes and streams, measurable values for water in recreation uses should be regarded as a lower bound or a minimum estimate of the actual values generated by maintaining instream flows and lake levels.

Failure to incorporate instream flow values into water management decisions can result in inefficient water use patterns. Daubert and Young's research on instream values in northern Colorado suggests that benefits generated by water resources could be enhanced by altering the timing of water storage and releases to increase instream flows during the fall recreation season. Recreational benefits associated with instream flows could be increased without decreasing water availability for irrigation, implying that payments to persuade irrigation right holders to alter water management practices in favor of recreation need not be large in this particular study area. Attention to the benefits generated by instream flows in other areas will help to identify other economically beneficial alterations in diversions for offstream uses.

Instream Flow Policies in the Southwestern States

While Arizona statutes do not explicitly recognize appropriations for instream flow maintenance, a 1976 court case held that surface water may be appropriated for instream recreation and fishing.(12) The Arizona Department of Water Resources (ADWR) issued two permits to the Nature Conservancy in 1983 to appropriate water for instream flow.(13) As of mid-1987 over twenty-five minimum instream flow permit applications were pending before ADWR and an Instream Flow Task Force had been appointed to assist ADWR in formulating new criteria and procedures for granting permits.(14)

In California, case law has ruled against appropriation where there is no diversion or other physical control over the water.(15) However, instream uses are declared to be reasonable and beneficial and the State Board must consider impacts on instream uses in approving new appropriations and transfers.(16)

In Colorado, the Colorado Water Conservation Board (CWCB) may appropriate water for instream flow and lake level maintenance.(17) Private entities are not authorized to appropriate water for instream flow protection but may dedicate water rights to the CWCB for instream flow maintenance. Appropriations by the board typically have been junior rights and thus do not guarantee minimum flows.(18) The CWCB has made appropriations on over 6,000 miles of streams and more than 500 lakes since the enabling legislation was passed in 1973. The CWCB is also responsible for filing objections to water transfers which may impair instream flow rights.(19)

Appropriations for instream flow and storage in lakes without a physical diversion have been granted in Nevada in specific instances.

Instream flow appropriations must be acquired through the same process as any other appropriation.(20) A 1987 county district court decision determined that the federal government, representing public interests, can hold instream rights under Nevada law but rejected an application by the Bureau of Land Management for instream rights to water livestock and wildlife on public lands. Both decisions are being appealed to the Nevada Supreme Court.(21)

New Mexico has no statutes pertaining to appropriation of water for instream flow maintenance, though recognition of instream flow rights has been considered in recent legislative sessions.(22) Case law and decisions by the State Engineer imply that diversion structures are necessary for water right appropriations.(23) There is, as of yet, no case law and no administrative precedent for considering impacts on instream flow levels (other than those which affect vested water rights) in evaluating a water transfer proposal.(24)

A Utah statute enacted in 1986 allows the State Division of Wildlife Resources to acquire established water rights to maintain flows for fish habitat. The division must have legislative approval to acquire a right for instream flows.(25)

Federal reserved rights associated with federal lands were recognized in a 1963 Supreme Court case and subsequent decisions, which established that the United States held dormant but potentially significant water rights in national forests and parks, military bases and other federally managed lands.(26) The priority of a reserved right has been determined to correspond to the date the land reservation was established, and the quantity of the right is that necessary to satisfy the purpose of the land reservation. Quantification of these rights is

a major issue in western water adjudications, as the establishment of these senior rights may undermine the strength of existing water rights in many regions. Since legal and administrative processes to quantify reserved rights are just getting under way in many areas, the extent of these rights remains to be clarified.(27)

Water Markets--Compatible With Instream Flow Protection?

Water transfers can affect recreational, ecological and environmental values associated with instream flows. While all states protect vested water rights, protection of instream flows that are not relied upon by water right holders is not a routine consideration in any southwestern state's water transfer approval proceedings. Generally, water rights for instream flow maintenance are few in number relative to rights for consumptive uses and most instream flow rights are recent appropriations and have low priority relative to other water rights. Those free flowing waters not protected by a water right have no legal recognition and thus create no legal basis for protesting transfers which will have adverse impacts on flow levels.

Population growth in the Southwest has resulted in a shift from rural to urban residents. New urban residents not only demand water for domestic and industrial use, they also demand recreational opportunities and aesthetic amenities which rely on water remaining in stream. As social values increasingly incorporate the importance of flowing waters, instream flow considerations may play a greater role in water transfer activity. Groups interested in protecting instream flows may wish to purchase senior appropriative rights rather than to acquire a junior right through a new appropriation. Where instream flow maintenance is recognized as a beneficial use so that water rights may be held for that

purpose, market transfers could become an important means of accomplishing instream flow protection. However, individuals wishing to protect stream flow levels do not have access to markets on the same terms as farmers, cities and industry. Only a few western states, including Arizona, have allowed a private party to hold a water right for the purpose of maintaining instream flows for recreation, wildlife habitat or aesthetic purposes. Even if these restrictions on private holdings were abolished, instream flows have public good characteristics which make it difficult to translate collective values for instream flows into dollars to bid for water rights in the market place.(28) Markets could do a better job of reflecting instream flow values if state laws permitted appropriation, purchase and seasonal leasing of rights for instream flow maintenance by both public and private organizations.

While instream flow protection can potentially be facilitated through market transactions, instream flow protection could also make water transfers more complicated and costly to implement. Eventually, as public interest and public trust concerns play a greater role in water transfer policy, instream flow impacts may be considered routinely in approval of transfers between consumptive users. Livingston and Miller (29) characterize conflict of interests between consumptive water users desiring to transfer water rights and interest groups seeking to protect instream flows as stark, unavoidable and pervasive. Shupe (30) notes that since instream flow rights typically are year-round rather than seasonal, and since they often extend along a stretch of a stream rather than being diverted at a single point, they are particularly constraining for new water development and for water

transfers. Consequently, establishment and enforcement of instream flow rights will continue to generate controversy among proponents of water marketing.

Summary

While substantial progress has been made in assessing the economic contributions of instream flows for recreation, it must be remembered that measurable recreation values are only a small portion of the total value generated by instream flows. Other real but hard-to-measure values stem from the role of instream flows in fish and wildlife habitat, in the aesthetic appeal of an area and from non-user values held by individuals who may never visit a site but none-the-less derive satisfaction from knowing free flowing waterways will be maintained.

The southwestern states have taken a variety of approaches to instream flow protection--from declaring instream flow maintenance a beneficial use to state agency acquisition of instream flow rights. Water transfers through market transactions are becoming common in many parts of the Southwest. Water markets can present opportunities for instream flow protection in states where private individuals can acquire water rights for such purposes. However, active water markets may also become a barrier to instream flow protection if market proponents perceive instream flow rights as complicating transfers of surface water rights for off stream uses.

A two-pronged policy approach could help facilitate instream flow protection. First, private parties should be allowed to acquire, by appropriation or purchase, water rights for the purpose of maintaining instream flows. Second, state agencies and local governments concerned with recreation, wildlife and tourism should have authority and funding

to acquire water rights for instream flow maintenance. The first policy allows private parties concerned with instream flows an "equal opportunity" to compete for scarce water resources in water markets and in the water right appropriation process with municipal, industrial and agricultural interests. The second approach is necessary because acquisition of instream flows by the private sector is handicapped by the "public good" nature of instream flows (31). Active participation by the public sector--state and local governments, in cooperation with federal agencies--will help to ensure that instream flows are protected at adequate levels and in desirable locations.

Endnotes and References

1. Water Resources Research published a collection of papers on valuing water-based recreation in its May 1987 issue (Vol.23, No. 5, p. 931-967) and these papers provide a current overview of valuation approaches.

2. J.T. Daubert and R.A. Young, "Economic Benefits From Instream Flow in a Colorado Mountain Stream." Colorado Water Resources Research Institute Completion Report No. 91. Fort Collins, Colorado State University, June, 1979.

3. R.G. Walsh, R.K. Ericson, D.J. Arosteguy and M.P. Hansen, "An Empirical Application of a Model For Estimating the Recreation Value of Instream Flow." Colorado Water Resources Research Institute Completion Report No. 101, Fort Collins, Colorado State University, October, 1980.

4. R.G. Walsh, R. Auckerman and R. Milton, "Measuring Benefits and the Economic Value of Water in Recreation on High Country Reservoirs." Colorado Water Resources Research Institute Completion Report No. 101, Fort Collins, Colorado State University, September, 1980.

5. P. miedrhi, E. Narayanan, B. Bishop and D. Larson, "A Methodology for Estimating Instream Flow Uses For Recreation." Logan, Utah Water Research Laboratory at Utah State University, 1984.

6. F.A. Ward, "Economics of Water Allocation to Instream Uses in a Fully Appropriated River Basin: Evidence From a New Mexico Wild River." Water Resources Research 23:381-392, March 1987.

7. J. Loomis, "The Economic Value of Instream Flow: Methodology and Benefit Estimates For Optimum Flows." Journal of Environmental Management, 24:169-179, 1987.

8. A. Bush, "Is the Trinity River Dying?" Instream Flow Needs Vol.2, American Fisheries Society, 1976, p.12.

9. F.H. Bollman, "A Simple comparison of Values: Salmon and Low Value Irrigation Crops." Paper from the Association of California Water Agencies, 1979, p.12.

10. The different concepts of value that serve as a basis for valuing wildlife and natural environments are discussed in more detail by B. Madariago and K. McConnell in "Exploring Existence Value," Water Resources Research,23:936-942, May, 1987.

11. R.G. Walsh, J.B. loomis, and R.A. Gilman, "Valuing Option, Existence and Bequest Demands for Wilderness." Land Economics Vol.60, Feb. 1984, p.14-29.

12. McClellan v. Jantzen 26 Ariz. Ariz. App. 723, 547 p.2d 494 (1976).

13. Arizona response to Western Governors' Association 1985 Questionnaire, p.6.

14. For an excellent discussion of instream flow issues and policies in Arizona see Wilkosz, Mary E. "The Role of Federal Natural Resource Agencies in Arizona's Instream Flow Policy" in Water Transfers in the Southwest: Explorations, S.C. Nunn, editor, University of Arizona, 1987 (can be ordered from Water Resources Research Center, University of Arizona).

15. Fullerton v. State Water Resources Control Board 90 Cal. App. 3d 590, 153 Cal. Rptr. 518 (1979); California Trout, Inv. v. State Water Resources Control Board 90 Cal. App. 3d 639, 153 Cal. Rptr. 518 (1979)

16. Cal. Water Code Sec. 1243.

17. Colo. Rev. Stat. Sec. 37-92-102(3) and Sec. 37-92-103(4).

18. Colorado response to Western States Water Council 1986 Questionnaire, p.2.

19. Brown et al, op. cit. p. 235-6. Water Market Update. Vol.1,o. 3, March. 1987, p.10.

20. Nevada response to Western Governor's Association 1985 Questionnaire p.5 and Western States Water Council 1986 Questionnaire, p.2.

21. The decisions by Judge n of Nevada's Elko County District Court are discussed in U.S. Water News Vol.3, No.12, June, 1987, p.4.

22. Instream Flow legislation was introduced in several recent legislative sessions, including the 1987 session, but no instream flow measures were passed.

23. Reynolds v. Miranda 83 New Mexico 443 493 p.2d 409 (1972).

24. Personal communication with David N. Stone, Water Rights Division, State Engineers' Office, Santa Fe, New Mexico, February, 1987.

25. Utah Code Ann. Sec. 73-3-3, as amended in 1986 and Utah response to Western States' Water Council 1986 Questionnaire, p.2.

26. Arizona v. California 373 U.S. 546 (1963), Cappaert v. United States 426, U.S. 128.

27. For a more thorough discussion of federal reserved rights and instream flow issues see Wilkosz, cited in note 14.

28. Public goods are resources characterized by non-rivalry in consumption, (they can simultaneously provide benefits to more than one individual) and/or non-excludability. (It is difficult or impossible to exclude those who do not pay from enjoying the benefits of the resource.) Many individuals who do place a positive value on a public good may be "free riders", enjoying the resource but making no payments. The aesthetic, environmental and recreation amenities provided by rivers, lakes and reservoirs are non-rival in the sense that they can simultaneously provide different kinds of benefits to many different individuals. Even when water rights are purchased for lake level or instream flow maintenance, the price paid will not represent total willingness to pay by all potential beneficiaries due to the free ridership phenomenon and the difficulty of collecting contributions from all who would benefit and excluding those who do not contribute from enjoying the resource.

29. M. Livingston, and T. Miller, "A Framework for Analyzing the Impact of Western Instream Water Rights on Choice Domains." Land Economics 62:306-312, August, 1986.

30. S.J. Shupe, "Emerging Forces in Western Water Law." Resource Law Notes Newsletter 2-8, Publication of the Ntural Resources Law Center, University of Colorado, Boulder, 1986.

31. See note 28 on the public goods characteristics of instream flows.

IN-STREAM FLOWS FOR CIENEGA CREEK, PIMA COUNTY, ARIZONA

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The Pima County Flood Control District is one of the many agencies and organizations which have filed in-stream flow applications in the State of Arizona. Our intent in filing the application for Cienega Creek is to protect a publicly owned natural resource.

In the next fifteen minutes I hope to give you an appreciation of what the resource values are, how we're trying to protect them, and finally, to explore a larger issue our application raises: namely, the need to protect in-stream flows from depletion by subsequent groundwater pumping.

THE RESOURCE

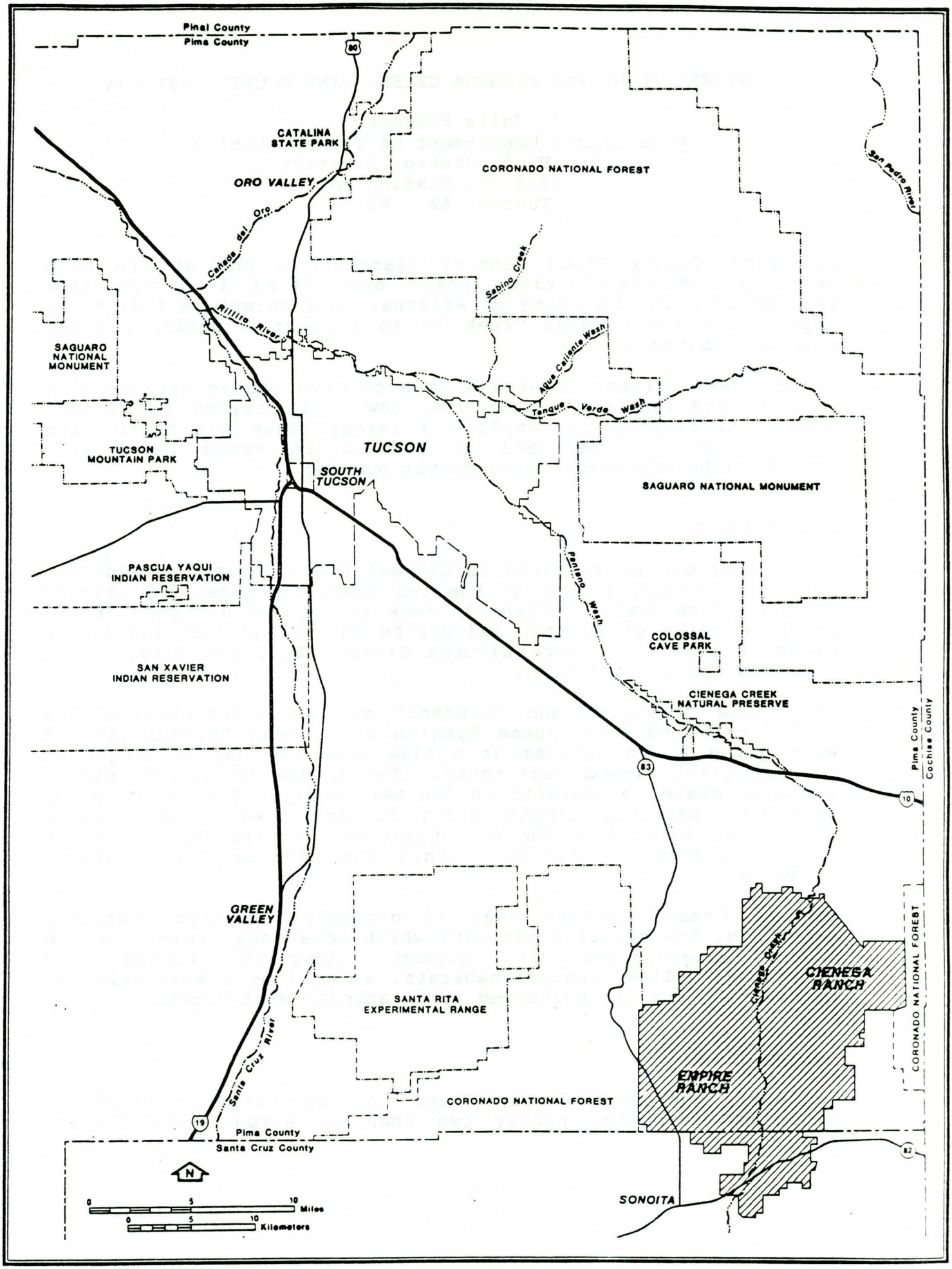
In this case, the resource is Cienega Creek, which in addition to Sabino Creek, is one of the two remaining perennial streams in the Tucson Basin. Cienega Creek is located upstream of the urbanized area of Tucson, and drains an area of over 400 square miles (Figure 1). Where Cienega Creek enters the city, it is known as the Pantano Wash.

The names "cienega" and "pantano" are an indication of its historical condition--these Spanish names mean "marshland" and were given to the stream at a time when the entire length of Cienega Creek flowed year-round. Today, due to arroyo-cutting and groundwater overdrafts in the metropolitan Tucson, only two perennial segments remain along Cienega Creek: the longer segment is located on the privately-owned Empire Ranch, and the shorter segment is located within the Cienega Creek Natural Preserve.

Cienega Creek supports what is probably the best remaining example of the riparian habitats which were once typical of the major watercourses in Tucson. Mesquite bosque and cottonwood-willow riparian habitats, as well as a population of native fish are all sustained by an abundance of water.

THE PRESERVE

In 1986, the Pima County Flood Control District Board of Directors purchased nearly two thousand acres along Cienega



LOCATION MAP

Creek, including one of the two perennial reaches. The purpose of the acquisition was three-fold. First, we wanted to remove the area from the development cycle in order to preserve the natural flood storage areas along the channel. Elsewhere in the Tucson Basin, we have found that when the floodplain is encroached by urbanization, downstream flood peaks are increased. To acquire and preserve overbank flood storage areas in urbanized Tucson is an expensive procedure. Along Cienega Creek we wished to take advantage of the relative lack of development and acquire floodprone lands in advance of urbanization, so that costly flood control measures could be avoided at a later date, consistent with the County's voter-approved Floodprone Lands Acquisition Program.

Second, we wanted to claim the Cienega Creek Natural Preserve as mitigative credit under the Section 404 permitting process. The acquisition occurred at a time when the Army Corps of Engineers was requesting that Pima County prepare a regional Section 404 application for all of the flood control projects in the District's five year Capital Improvement Program.

For those of you who are not familiar with the Section 404 process, it refers to Section 404 of the Clean Water Act, which has been interpreted to give the Army Corps of Engineers authority to regulate activities which might adversely affect riparian environments, including those along ephemeral washes. Pima County sought to establish the Cienega Creek Natural Preserve to demonstrate our commitment to riparian habitat conservation, and to mitigate any potential adverse effects caused by our flood control activities elsewhere in the Basin.

In order to increase the level of riparian habitat protection, the Board approved the in-stream flow application as well as several other actions: designating the Preserve a State Natural Area, nominating the perennial reach of the stream for protection under the State Unique Waters Program, controlling the access to Preserve, and monitoring the continuation of grazing within the Preserve.

The Board of Directors approved the in-stream application not only to preserve the natural qualities of the area, but also to ensure continuation of natural recharge to the Tucson Basin aquifer. Because downstream portions of Cienega Creek contribute recharge to the Tucson Basin aquifer, they felt there was a clear public interest to be served by securing an in-stream flow appropriation.

THE IN-STREAM FLOW APPLICATIONS

We are pursuing two separate means of achieving an in-stream flow appropriation along Cienega Creek: first, we have had an existing in-stream flow application assigned to Pima County's name, and second, we have requested to change the purpose of

existing stock watering rights to in-stream wildlife, recreation and recharge purposes.

In 1983, the former owner of the land filed an application for in-stream flow. Upon purchase of the land and water rights by Pima County, we transferred the application to our name. I should note that this 1983 application was protested by a major land owner just downstream of the Cienega Creek Natural Preserve. The Horizon Corporation possesses water rights along the Cienega Creek which total 1300 acre-feet per year. Their protest illustrates the widespread misunderstanding of the effects of in-stream appropriation, because our proposed in-stream flow right would not diminish their flows downstream, but in fact would help ensure that flows continue to reach Horizon's point of diversion.
The second strategy, which is the change of purpose of existing water rights, presents a means of achieving in-stream flows with less conflict and without increasing total appropriation levels along a given stream. Cienega Creek has been grazed at least since the 1880's, and several stock watering rights with early priority dates are associated with the stream.

Since acquiring the Cienega Creek property, the Flood Control District has retired part of the Preserve from grazing, and has requested that the purpose of associated stock watering rights be transferred to in-stream flows. However, the stock watering rights, when converted from acre-feet to cubic feet per second, cover only a fraction of our minimum base flow needs.

Nonetheless, the idea of changing the purpose of existing water rights to in-stream flows is an important one, particularly in overappropriated watersheds. New in-stream flow appropriations in practically any area of the State are likely to generate considerable opposition, and it's possible that some amount of this conflict can be avoided through purchase, lease, or donation of existing irrigation, stock, mining, municipal or domestic water rights. I must mention, however, that ADWR has not yet made a determination as to whether this means of obtaining in-stream flows will be allowed in the State of Arizona.

Assuming that it is, a few additional questions come to mind that the water rights experts will have to answer. First, will the priority date remain intact? If so, the purchase and transfer of existing water rights to in-stream flows becomes a much more meaningful technique for preserving riparian values. Some states, such as Wyoming and Oregon, have already determined that existing water rights may be transferred to in-stream flows with the priority date intact. Second, within what bounds can the place of use be changed? Could an agency change the place of use of several existing water rights to the same locality so that a higher amount of in-stream flow could be protected?

DEPLETION BY IN-STREAM FLOWS BY GROUNDWATER PUMPING

Assuming that in-stream flow appropriations withstand the legal challenges that are sure to come, the next challenge will be to resolve the potential conflicts between in-stream flow appropriations and groundwater pumping.

For many of the lower elevation streams of southern Arizona, the presence of perennial and intermittent streamflow is directly related to shallow groundwater underflows obstructed by outcrops of relatively impermeable bedrock (Hendrickson and Minckley, 1985). This was historically true of the perennial portions of the Santa Cruz River, for instance, where outcrops of basalt near mission San Xavier del Bac and at Sentinel Peak forced groundwater to the surface (Betancourt and Turner, in press).

It is also true of Cienega Creek, where outcrops of the Pantano claystone and a dense volcanic intrusive form underground barriers to groundwater flow. Even where outcrops are not visible, the bedrock may lie only a few feet under the channel alluvium. This became evident during a recent storm event, in which channel scouring exposed bedrock in reaches where none had been visible previously. Where the depth to bedrock becomes great enough to store all of the groundwater underflow, the base flows disappear.

Base flow discharges at bedrock outcrops are not great, only about 0.5 cfs during the summer, and 1 to 1.5 cfs during the winter when evapotranspiration decreases (Armer, unpub. data; Fonseca, field observation; U. S. Geological Survey, 1979). These base flows mean only about a thousand acre-feet of groundwater throughflow passes through the channel on an annual basis. The rest passes through the bedrock sections as ephemeral storm flows averaging 4000 acre-feet per year, which then infiltrates in areas where the alluvial thickness is greater. The low volume of base flow discharge at bedrock control sections suggest that a stream of this type could be vulnerable to upstream groundwater depletion.

Annual groundwater withdrawals upstream of the Cienega Creek Natural Preserve currently amount to only about 1000 acre-feet per year, making the Cienega Creek Basin one of the least depleted groundwater aquifers near Tucson. However pumping is projected to more than double with the construction of Phase I of the Empirita Ranch development (Montgomery and Associates, 1985). An additional 1600 acre-feet per year for Phase I will be drawn from the alluvial channel gravels of Cienega Creek, approximately one mile upstream of the Cienega Creek Natural Preserve.

Based upon a review of the hydrogeologic study submitted for the development, ADWR has concluded that the groundwater pumping will not affect surface or subsurface flows downstream (ADWR, 1986a; ADWR, 1986b). I hope that they're right, but I

think we all realize that large uncertainties exist in nearly all aquifer models, and should our assumptions prove false, the riparian resources of the Cienega Creek Natural Preserve may well be irreparably damaged. Despite these uncertainties, the Board of Supervisors approved the Empirita Ranch Area Plan, but required that the developers submit a water quantity and quality monitoring program prior to the approval of more detailed development plans.

Further upstream, the Empire and Cienega Ranches, which include the other perennial reach of Cienega Creek, may also be subject to future escalations of groundwater pumping. The Pima County Board of Supervisors has authorized a bond election to acquire the property, but should the voters reject the acquisition the Ranches will probably become the site of a new urban center, as was proposed in 1970 in the Empire Ranch Area Plan. In response to the proposed development, hydrologic analyses of the effects of urbanization concluded that the projected water use of 10,000 acre-feet per year would dry up the perennial reach of Cienega Creek and possibly affect streamflows in the Babocomari and Sonoita Rivers as well (Arizona Water Commission, 1972; Simpson, 1983).

Because essentially all of the watershed upstream of the Cienega Creek Natural Preserve lies outside the Tucson Active Management Area (AMA), it is an attractive area for future growth. Groundwater pumping is not restricted in the Cienega Creek basin, even though it clearly contributes recharge to the Tucson AMA. The only constraining influence outside the AMA is the possibility of damage to adjacent landholders. However, adjacent landholders would not have legal standing to file suit until adverse physical impacts had already occurred (Greenberg Chin Consultants, 1987).

What opportunities exist, then, to reconcile preservation of in-stream flows with future groundwater pumping rights? Arizona law (A.R.S. 45-301) recognizes groundwater flowing in channels with defined beds and banks as surface water subject to appropriation. This law would seem to offer a means of addressing conjunctive management of groundwater and surface water, but at least in ADWR's review of water adequacy studies, it is routinely ignored.

Some minor level of protection might be afforded the surface flows through the Endangered Species Act (Greenberg Chin Consultants, 1987). The endangered Gila topminnow lives in the perennial reach within the Empire Ranch. Federal funding, assistance or sponsorship of activities which jeopardize the habitat of the topminnow would be precluded.

However, I am not at all confident that the Endangered Species Act or any in-stream flow appropriations will make a bit of difference against essentially unregulated groundwater pumping in the Cienega Creek Basin. I can only hope that we in the State of Arizona will attempt to improve recognition of the

hydrologic connection between groundwater pumping and surface water in our laws and in our practices, not only with regard to in-stream flows but all other water resources issues.

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THE SIGNIFICANCE OF INSTREAM FLOW RIGHTS IN THE NATURE CONSERVANCY'S EFFORTS

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An Introduction to The Nature Conservancy

The Nature Conservancy (TNC) is an international non-profit organization represented by over 350,000 individual members and over 600 corporate associate sponsors. The organization is focused around its stated mission: "to find, protect, and maintain the best examples of communities, ecosystems, and endangered species in the natural world." The organization is thereby committed to the global preservation of "natural diversity."

Why Preserve Natural Diversity?

The reasons for protecting natural diversity are numerous, many of which are obvious but some also less apparent, and many are pragmatic justifications but some too are esoteric in nature. For instance, in terms of pragmatic utility, the benefits directly accruing to mankind include the usage of wild species for development of medicines and vaccines (only 15% of the world's plants have been examined for this purpose to date), or for their use in developing genetic variations in food crops that can alleviate the problems of food shortages and poor food quality. We also know that each of these elements in the puzzle of the natural world are inextricably inter-connected; that is, the loss of any one species can grossly impact the survivability of numerous other species. In a more esoteric sense, the preservation of plant and animal species guarantes an opportunity for future generations of mankind to enjoy the sight and pleasures of these elements of our natural world. There is also a growing acknowledgement, perhaps in a spiritual sense, of the inherent right to life for every life form, and that mankind is not given the right to drive any species from existence on this planet.

Accomplishments of The Nature Conservancy

TNC is entirely a privately funded organization, receiving no support from federal or state agencies or other tax-generated revenues. TNC's funding comes from concerned individuals and corporations. During its 35 years of existence, the organization has managed to protect over 3 million acres in the 50 states, Canada, Latin America, and the Carribean. This protection has been accomplished primarily by outright purchase of land areas deemed critical to protect endangered species or natural communites. These properties are subsequently retained by TNC for management or, in certain cases where a state or federal agency is deemed capable of managing the property in a manner consistent with TNC's mission, turned over to public agencies. TNC currently owns over 2½ million acres of natural habitat, represented by over 1000 individual nature preserves - the largest privately owned nature preserve system in the world.

The Arizona Nature Conservancy. The Arizona Chapter of the Nature Conservancy presently boasts some 10,000 members and 8 nature preserves, ranging in size up to the Muleshoe Preserve covering 55,000 acres in southeastern Arizona. Virtually every one of these Arizona preserves is inextricably dependent upon water, and are referred to as "riparian," or streamside, habitats. Arizona is faced with the fact that we have now lost 90% of the riparian habitat existent in the state 100 years ago. Arizona's wonderful diversity of wildlife is highly jeopardized by that fact; at least 85% of the state's wildlife species are directly dependant upon that remaining 10% for their survival. Water is absolutely vital to our wildlife species and to the plant communities that support them. For these reasons, the efforts of the Arizona Chapter are commonly regarded with high national priority.

Instream Flow Rights And Arizona's Natural Environment

The foregone discussion of TNC's efforts may read like a direct-mail solicitation for membership, but is important to place TNC'S instream flow rights considerations into proper context. The historical development of instream flow rights in the West has been amply documented in the text of other papers presented at this conference. However, it may be beneficial to summarize the Arizona court's interpretation of various points of contention in allocating water resources to natural environment uses. Of significant interest in this historical sequence is TNC's acquisition of two separate private-party appropriation permits for instream flow on our preserves.

Significant Court Decisions Pertaining to Instream Flow Rights in Arizona

Arizona's doctrine of prior appropriation, governing the use of all public surface water, is not unusual and closely mirrored by similar doctrines in most other western states. However, one of the doctrine's basic tenets, that of "beneficial use," has been subject to interpretation by the Arizona courts. Appropriate beneficial uses are specifically categorized in the doctrine, which until 1941 included only "domestic, municipal, irrigation, stock watering, water power, and mining uses." In 1941,the legislature amended the statutes by adding "wildlife, including fish" to the list of uses for which there could be delegated an appropriation of water (Scribner, 1979). In 1967, the legislature added "recreation" to the list of approved beneficial uses. The courts have subsequently moved to accept the general preservation of riparian environments, including plants as well as wildlife, as being an appropriate extension of the intent of the wildlife and recreational uses. This concept is commonly supported by agents of the state, such as this statement from the Attorney General's office (Clifford and Lee, 1987):

> "Instream flows should be sufficient to support both the aquatic and riparian ecosystems....The Arizona Game and Fish Department has the responsibility for all wildlife of this state. We cannot separate the species from its habitat. Both must be preserved to conserve wildlife."

This sentiment is echoed by Arizona's Game and Fish Department (Shroufe, 1987)

> "Realistically, one cannot separate any organism from its essential habitat elements and expect to retain a viable population. Provisions for the maintenance of cottonwood trees, as well as any other critical habitat element dependant upon flowing water, must be included within the documentation authorizing instream appropriations, otherwise, the objectives for the instream program would be impossible to attain."

Although Arizona law has been amended in recent years to reflect the general concensus that recreational and wildlife uses of water are appropriate "beneficial" uses, additional strengthening of these statutes will be desirable to minimize legal objection to instream appropriations for environmental and ecological benefits, particularly in the case of private appropriators. TNC's experience in Arizona is a noteworthy case in point.

The Arizona Nature Conservancy Experience

On April 29, 1983 the Arizona Department of Water Resources (DWR) granted what constitutes two instream flow permits to The Arizona Nature Conservancy. One of these permits was for Ramsey Creek within the Ramsey Canyon Preserve and a second for O'Donnell Creek through the Canelo Hills Cienega Preserve. These permits are of utmost significance, because prior to this authorization the only private party instream flow right had been issued in Washington, to a biologist who sought to appropriate water for the purpose of propagating fish.

TNC's permit application at these two preserves did not pass without some fairly substantial objections. However, the focus of the objections (led by protestants including the U.S.Dept. of the Interior, Bureau of Indian Affairs, and numerous irrigation and water companies as well as neighboring residents) were based upon an ill-founded or confused perception that TNC intended to build a dam to utilize the allocated water and that TNC could later stand to profit from the transfer of this right to a consumptive user.

The DWR, in rejecting these objections and issuing the TNC permits, clarified TNC's intention by making the appropriation subject to the following conditions (DWR, 1983):

"1. There shall be no impoundments of public waters other than by the exising dams;
2. There shall be no interference with the natural flow of Ramsey Creek and O'Donnell Creek other than by the exising dams;
3. There shall be no consumptive use of public waters other than is caused by the natural habitat;
4. There shall be no change in water quality by reason of Applicant's use of these public waters other than as caused by the natural habitat."

Additional objections to the TNC permits surfaced in a "Motion for Rehearing," summarized in DWR's "Order Denying Motion for Rehearing" (DWR, 1983). The protestants questioned a private party's ability to hold an instream appropration. This contention is supported by the fact that characteristically, state statutes that authorize instream appropriation or maintenance of minimum flow is the requirement that the appropriator be the state or a subdivison thereof.

This issue is further muddled by conflicting interpretations of Section 404of the Clean Water Act. Loosely interpreted, the State is believed to retain ownership of all stream beds associated with "navigable" waters. This interpretation has at times included all perennial streams and most ephemeral washes in Arizona. However, DWR ruled that the state's rights pertain only to the severance and transfer of vested water rights, which exclude instream flow appropriations. DWR further concluded

that state statutes provide that "any person....may appropriate unappropriated water "if the appropriation is to be put to beneficial use." Beneficial use, as discussed earlier, now includes the purposes for which TNC sought to use the water right. The DWR therefore denied the motion for rehearing.

The present status of the private party issue in Arizona's instream flow program is perhaps best summarized by the Attorney General's Office:

> "Since DWR has chosen to issue instream flow permits to the Nature Conservancy, if may be more appropriate to proceed in establishing guidelines for use in determing which private applicants should be granted an instream flow permit and which should be denied. By establishing a rigid set of requirements for issuance of such permits, any wasteful or non-beneficial instream applications could be avoided. DWR could determine whether or not the application is meritorious and whether it serves the ends of recreation and wildlife, including fish, and whether it is in the public interest."

Clearly, The Nature Conservancy has been recognized as a case of a private organization working towards significant public benefits. Therefore, to the degree that TNC uses such appropriation to benefit public ideals, beneficial ends are served and such appropriation should be allowed.

Major Obstacles To Be Overcome

The Nature Conservancy's efforts to protect our natural heritage in perpetuity still face some substantial obstacles in Arizona's convoluted instream flow rights program. A clear definition of the "navigable" waterways issue spells complications not only for the issuance of instream flow rights to private parties, but in questions of unrestricted public access along these waterways. TNC's ability to control such access is paramount to our efforts to preserve riparian habitat in Arizona.

Also at issue is the means by which the quantity of an instream flow right will be issued. At Ramsey Creek and O'Donnell Creek, the rights to continous, minimum instream flows of 0.48 cubic feet per second (cfs) and 0.45 cfs, respectively, were predicated upon TNC's monitoring of existing flow conditions within these streams (the allocated flows were based upon observed minimum flows during the monitoring period.) However, the DWR explicitly reserved the right to reduce these flow levels should on-going monitoring efforts reveal a lower observed flow condition.

A multitude of potential flow assessment methodologies are now being reviewed by an Instream Flow Task Force comprised of interested representatives from federal and state agencies and private interest. The final guidelines for defining these instream flow rights may become quite time-consuming, expensive, and technically demanding, all of which may lead to undesirable delays in accomplishing instream flow objectives in the state.

Another complication is the appropriation statute's limited focus on surface water allocation. Many of Arizona's streams are strongly inter-depend-end upon hydrologically-connected alluvial ground water aquifers. In such a case, the flow in the surface stream is directly dependent upon subsurface water conditions; if an alluvial ground water supply is not judiciously regulated in conjunction with the surface stream, conflicting allocations of surface and groundwater supplies will expectedly arise. The alluvial conditions will need to be thoroughly evaluated as part of the instream flow allocation, further leading to additional complications in evaluating the appropriate flow magnitudes to be allocated.

In summary, however,TNC supports an aggressive pursuit to addressing these surmountable obstacles. What we are unable to save in the very near future may be forever lost to those who will succeed us.

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AN APPROACH TO ASSESSING INSTREAM FLOW WATER RIGHTS: SAN PEDRO RIVER, ARIZONA

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This paper describes the approach to a recent assessment of water conditions, water-dependent resource values, and mechanisms for maintaining instream flows for the BLM San Pedro River properties in southern Arizona. The natural values of the Bureau of Land Management (BLM) San Pedro River properties are inextricably linked to water resources. Riparian vegetation, wildlife, fisheries, recreation and other water-related natural values depend on instream flows (including floods and related ground-water conditions). Baseflows and riparian zone water tables are maintained almost entirely by inflows from the regional ground-water aquifer. Either regional ground-water depletions or localized (near-stream) drawdowns in the floodplain aquifer can reduce instream flows and concurrently lower riparian zone water tables. The cottonwood stands along the San Pedro River are especially sensitive to water table declines. Periodic floodflows are required for vegetation reproduction, floodplain development, and channel maintenance and evolution.

The Federal Land Policy and Management Act (FLPMA) affords BLM a wide range of land management alternatives. FLPMA, however, does not guarantee that water resources will be available to achieve land management objectives. Opportunities available to BLM for the protection of instream flows and related ground-water tables are founded in concepts of water law--both State and Federal. The viability of any mechanism (legal, administrative, or technical) which serves to protect the water-dependent natural values of the San Pedro River relies on a thorough scientific analysis of the interrelationships between natural characteristics of the area and water availability.

Introduction

BLM's Safford District recently acquired 44,000 acres of riparian land along the San Pedro River in southeastern Arizona on behalf of the United States so that valuable riparian ecosystems, prehistoric and historic ruins, and varied wildlife may be protected and managed for the American public.

Legislation has been introduced in Congress to designate the acquired land as the San Pedro Riparian National Conservation Area. As proposed, the BLM is authorized to manage the area in accordance with the principles of the Federal Land Policy and Management Act (FLPMA) in a manner that "conserves, protects, and enhances the riparian, wildlife, archaeological, paleontological, scientific, cultural, educational, and recreational resources of the conservation area." Critical to the management of the San Pedro River properties is the management of its water resource. In particular, baseflows contributed from the regional aquifer must be preserved if the river is to remain distinguished from most desert arroyos in southern Arizona. Instream flow water rights must be obtained and the ground-water resource must be effectively managed if riparian and other resource values of the river are to be conserved, protected, and enhanced.

The BLM San Pedro River Water Resources Assessment Project was an interdisciplinary team effort intended to develop (for BLM management) legal, administrative, and technical alternatives for managing instream flows and maintaining favorable water conditions for riparian vegetation growth and reproduction.

Six major objectives were identified for the project:

1. Determine the natural flow regime (average annual flow duration, median monthly flows, flood frequencies, and low-flow characteristics and trends) and channel characteristics of the San Pedro.

2. Determine riparian vegetation water requirements, current ground-water conditions in the riparian zone, and critical or threshold riparian ground-water conditions for riparian vegetation maintenance.

3. Determine surface-water/ground-water relationships including surface recharge of the floodplain aquifer and the effect, if any, of ground-water pumping on streamflow.

4. Develop recommended minimum flow conditions for maintenance of dependent riparian and instream values.

5. Develop, in coordination with the Interior Department, Department of Justice, and State of Arizona, a strategy for acquiring an instream flow water right sufficient to maintain instream flow-dependent resource values.

6. Identify other management opportunities (in addition to a water right application) including land management alternatives, cooperative management alternatives (with other agencies), monitoring, and further research.

Approach and Methods

The project approach was keyed to two concurrent activities: (1) a comprehensive resource assessment and, (2) a legal analysis and management assessment. The resource assessment consisted of four basic steps:

1. Quantify hydrologic and geomorphic conditions.

2. Describe water-dependent values, processes, and conditions.

3. Relate resource values to water and geomorphic conditions.

4. Evaluate the influence of alternative flow levels on resource values.

The legal analysis and management assessment consisted of three basic steps:

1. Focus data collection efforts.

2. Adjust legal analysis to integrate resource concerns not identified in initial project scoping.

3. Translate identified resource values into legal entitlements protectable in State or Federal courts.

An effective project required nearly continuous feedback between the two concurrent activities. The process began with very general concepts of science and law and resulted in a precise description of specific resource values for which specific legal and management protection mechanisms are prescribed. This metamorphosis would be time-consuming and difficult without the interplay of the various disciplines.

The project approach was based upon three overriding concepts. First, most rivers and associated resources have unique conditions, physical processes, and values that need to be carefully evaluated and described before deciding on more specific evaluation techniques. Second, the evaluation of water resource conditions should be keyed to an analysis of water-dependent resource values and how those values are influenced by changes in water conditions. Third, the wide array of management opportunities and constraints means that specific aspects of a water management strategy--for example water rights alternatives--must be evaluated within the larger context of alternative technical and administrative management options. All project recommendations were based on expert professional judgment. The specific bodies of knowledge, sources of experience, and analytical tools used to support those judgments were determined by the individual experts.

With these concepts in mind, an interdisciplinary team was formed representing key water resource conditions, values, and issues. Disciplines represented on the Project team include surface water hydrology/geomorphology, ground-water hydrology, fisheries, riparian vegetation, recreation, and water rights. The way in which conditions, values, and management recommendations are integrated in an overall process is depicted in Figure 1.

Information developed by the Project was used to:

1. Describe associations between vegetation class, landform position, and depth-to-water.

2. Describe riparian vegetation water requirements (from literature).

3. Describe relationships between streamflow and riparian area water table depths.

4. Describe relationships (if any) between streamflow and regional (deep) aquifer water table depths.

5. Identify reaches that gain streamflow from ground water and reaches that lose streamflow to ground water.

6. Quantify flood-frequency and discharge-depth (inundation) relationships.

7. Describe channel morphology and long-term channel evolution.

8. Analyze water-dependent recreation and aesthetic attributes.

9. Analyze fishery values and instream flow requirements.

Alternative legal strategies for establishing and managing instream flows were also evaluated. Issues included:

1. Establishing and protecting minimum flows for maintenance of instream fisheries resources,

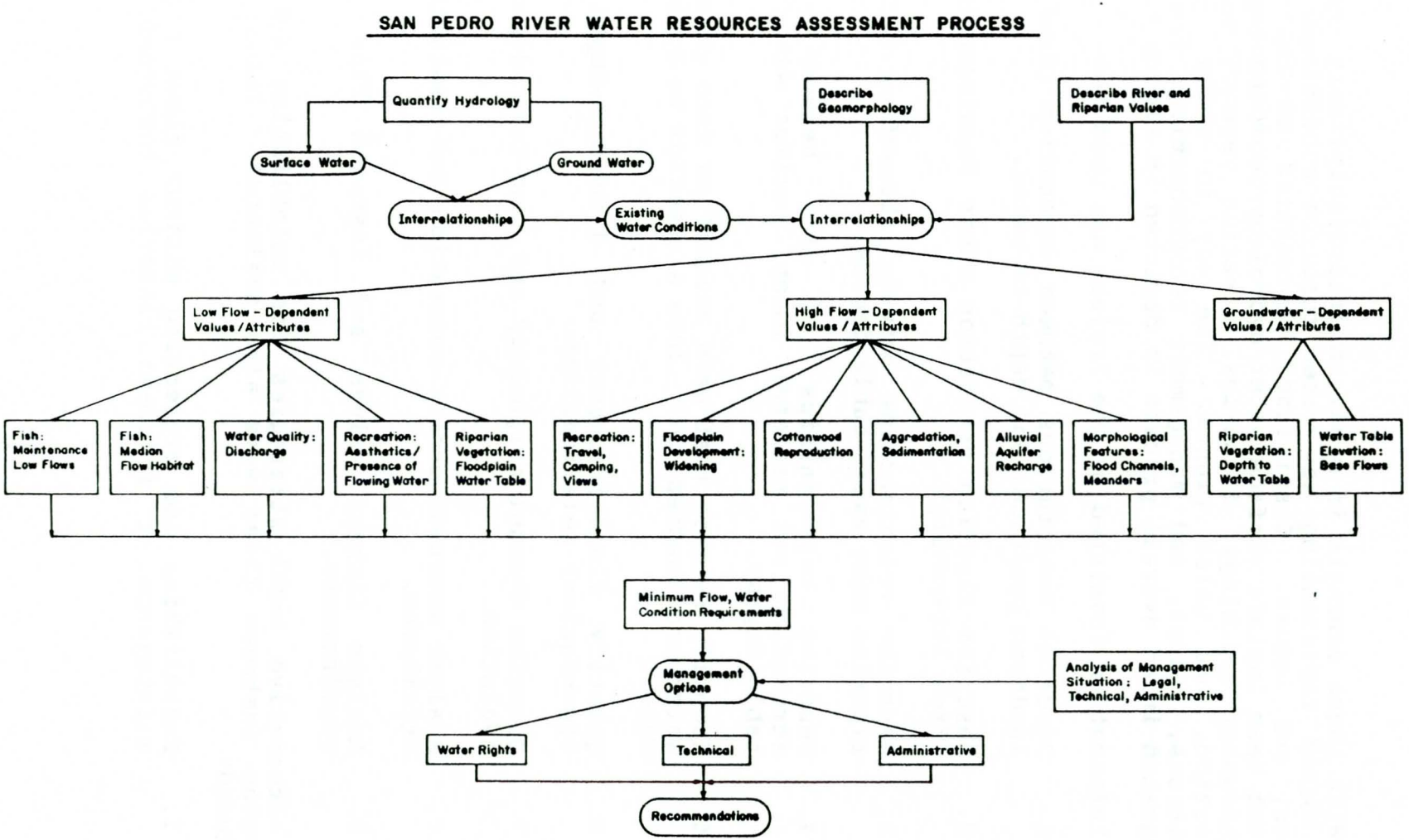

Figure 1. San Pedro River project water resources assessment process.

recreation values, wildlife water, and riparian area water table conditions (including the management of existing water rights and the possible acquisition of additional water rights).

2. Quantifying the importance of very high flows to vegetation reproduction and channel morphology.

3. Establishing ground-water/surface-water connections and identifying appropriate monitoring and protection mechanisms.

The instream flow quantification was the result of a team evaluation of flow levels and associated water conditions. Minimum acceptable flows were identified by individuals representing the water-dependent resource values based upon a description of how alternative flow levels influence both instream and riparian zone water conditions. Consideration was also given to trends in historic resource and hydrologic conditions. All recommended flows represent, in effect, expert professional judgments.

Recommendations

Water Rights

To maintain water supplies sufficient to sustain the natural values of the San Pedro River, BLM needed to perfect a water right recognized under Arizona law. Whether that right is based on Federal law (reserved water right) or State law (instream flow appropriation), BLM requires some cognizable right to the waters of the San Pedro River.

The basic components of the recommended water rights strategy were:

1. to amend the BLM Application to Appropriate No. 33-90103 to reflect the instream flow values recommended by this Project, and

2. the continued assertion of the senior surface water rights downstream.

The BLM Application to Appropriate was originally filed by the Huachuca Audubon Society, Chiricahua Sierra Club, and Defenders of Wildlife on August 12, 1985, prior to the BLM's acquisition of the San Pedro properties, and was subsequently assigned to BLM on May 25, 1986. Although this is a very junior appropriation, there are no senior surface rights above the BLM properties or within the study corridor except for the St. David Irrigation Company located at the terminus of the study corridor. Downstream senior water rights are essentially sufficient to meet baseflow requirements in the study corridor, while the BLM application would have provision for high flows.

The significance of senior downstream appropriators is lost as a benefit to the instream flow protection of the San Pedro River if, as is currently the case, the State of Arizona does not recognize the impact of ground-water depletions on surface water supplies. Therefore, as part of its strategy, BLM needed to establish the ground-water/surface-water connection, and then obtain a meaningful priority once that connection was established.

The ground-water/surface-water connection was established through an analysis of water table data and river base flows, and by applying a computer ground-water modeling routine. Alternatives presented to BLM management for achieving legal recognition of the connection between ground-water and surface water included:

1. agreements with major ground-water users in the basin,

2. designation of the basin as an Active Management Area under the Arizona Ground-Water Management Act, or

3. assertion of a Federal Reserved Water Right. In addition, BLM may wish to consider acquisition, transfer, or change in use of the Tenneco wells.

Instream Flows

Instream flow recommendations were developed and expressed as a percentage of median daily flows for each month in the year. Median flows were believed to be more representative of daily flow conditions than mean flows because of the highly skewed nature of daily flow distributions. The annual San Pedro River flow regime was

stratified into four distinct seasons to facilitate the instream flow analyses. The April-June spring season is the primary low-flow period, and the July-September summer season is the primary high (flood) flow period for the river. A secondary low-flow period occurs during the fall (October-November), and a secondary high-flow period occurs during the winter (December-March). All flow recommendations reflect consideration for historic baseflow declines.

All instream flow recommendations were keyed to minimum flow amounts required to maintain riparian and instream resource values. However, different values supported flow recommendations in different seasons. For example, winter flows were keyed to fisheries. Spring and fall flows were keyed to riparian water tables, recreation/aesthetics, and fisheries. Summer flows were keyed to cottonwood reproduction, and channel morphology and evolution.

Recommended Instream Flows for the BLM San Pedro River Properties

Period	Month	Flow Recommendation, cfs	
		Palominas	Charleston/Tombstone
Fall	Oct.	3.7	12.2
	Nov	3.6	13.6
Winter	Dec.	5.5**	17.1**
	Jan.	7.9**	19.5**
	Feb.	8.6**	20.3**
	Mar.	6.3**	18.9**
Spring	April	2.5	12.2
	May	1.2	7.9
	June	0.6	4.2
Summer	July	7.0*	19.0*
	Aug.	7.0*	19.0*
	Sept.	7.0*	19.0*

* This value or 60% of the instantaneous flow, whichever is greater.

** This value or 80% of the instantaneous flow, whichever is greater.

Resource Management and Monitoring

Additional resource management recommendations that support the purposes of a water right were also developed. Recommendations were developed for land acquisitions, pumping of BLM wells, livestock grazing, channel enhancement structures, erosion control structures, water control structures, vegetation plantings, highway bridge designs, intergovernmental coordination, and future research. In addition, monitoring recommendations for ground-water levels, channel adjustments, and water quality were developed.

Conclusions

The approach to assessing instream flow-water rights for BLM San Pedro properties was keyed to an analysis of water-dependent values and crafted to fit within the framework of Arizona water law and existing administrative constraints. The approach recognized that a quantification of this sort cannot be accomplished by strictly applying "handbook" methods, but must--in part--employ professional analysis and judgment. The approach was efficient and, we believe, provided a meaningful and defensible assessment of water conditions required to maintain the unique riparian and instream values on the San Pedro River.

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APACHE-SITGREAVES NATIONAL FORESTS
RIPARIAN AREA MANAGEMENT
-A FOCUS ON THE FUTURE-

Riparian areas are recognized as one of the most productive and attractive of all wildlife and fish habitat; the attention being given these habitats is increasing at an accelerating rate. Because of this, I appreciate the chance to take part in a discussion of the problems and opportunities in riparian ecosystems. I have a deep interest in the topic because of the challenges of riparian management on the Apache-Sitgreaves National Forests. The fact that the American Water Resources Association is sponsoring this symposium shows there is also deep interest among many segments of the public, Federal, and State Government. I hope that emphasis is placed on obtaining mutual understanding and respect of all interests as a basis for management of these riparian ecosystems.

It might be well to reflect on the importance of these areas in the history of Arizona. Because of the diversity of plant and animal life, riparian areas were an important source of game and other food staples for early Arizona natives.

This was followed by early settlement because of the availability of water for domestic use. With the advent of mechanized transportation, they became important locations for roads; sometimes the only flat land in mountainous terrain. In more recent years and with the availability of more leisure time, they became prime areas for recreation.

Hence, the type and intensity of resource use in riparian areas has been a public issue of varying degree for decades. Today, with competition increasing for limited resources and a strong public concern for the quality of the natural environment, the issue is intensifying. The issue relates to instances on public lands where a broad range of interests compete for limited resources.

Management of riparian zones on lands of the National Forest system must be guided by recognition that there are a number of important uses that can be made of these areas and a number of values to be considered.

With this as our guide, we are stressing management that minimizes conflicts, optimizing compatible uses and providing protection of the ecosystem. We have a way to go, but we are continuing to learn. Even more important is the need to educate the various interested publics towards these efforts.

Livestock management is one element of a total management plan on all lands of the National Forest system, including riparian areas. Through innovative management and investments in developments that emphasize compatible use, grazing can fit into the total management plan for riparian areas. It requires, of course, that all other uses and values are adequately considered and protected.

We realize that if not properly managed, grazing can have serious negative impacts on other values and resources in these sensitive areas. Looking back in the history of the West, we can see where uncontrolled grazing has resulted in severe damage. Sore spots remain and are somewhat concentrated in riparian areas because livestock, as with people, are attracted to the riparian areas by its water, shade, and green vegetation.

Perhaps at this point we should consider briefly just where a riparian area begins and ends. It is important to our technical people to accurately define the area in order to classify water and associated land. It is equally important for all of you to know what we mean when we are talking about riparian zones. Leaving the gray areas to be defined by specialists, I think we generally share a common perception of riparian area, that of being the land areas closely associated with water, usually supporting vegetation considerably different from that in the adjacent inland area. In more technical terms, it can be defined as an area or transitional ecosystem that lies between aquatic and terrestrial ecosystems. It is important to recognize that riparian areas are highly variable---from an overhang of long meadow grasses or a thin line of willows to a broad river valley covered with cottonwoods.

With reference to basic authority for managing the resources associated with riparian areas, we have adequate authority to do a good job. Legislation such as the 1974 Resource Planning Act and the National Forest Management Act of 1976 augment already existing authorities. In general, the regulations call for an interdisciplinary approach with full public participation. Specifically, the regulations, in several places, require special consideration for wetlands and flood plains which we interpret to include riparian areas. The recent Land Management Plan for the Apache-Sitgreaves National Forests directs us to place emphasis on the fish and wildlife resources in riparian zones over other uses.

The Apache-Sitgreaves National Forests have a particular importance and contribution to the riparian resources of Arizona. We have approximately 450 miles of fishable streams for cold water fish and provide over 2000 acres of cold water lake habitat. Stream mileage is the largest of any National Forest in Arizona, and we provide 52% of the cold water lakes on National Forests in Arizona. This equates to the Apache-Sitgreaves contributing 71% of the cold water fishing in Arizona and 49% of total fishing on Arizona National Forests. In fact, the Apache-Sitgreaves ranks fifth in the Nation in RVD's for cold water fishing, and tenth in the Nation in RVD's among National Forests in total angling. The value of the fisheries on our Forest is set at $5,800,000 annually.

It is anticipated that the demand and relative value of cold water fisheries on the Apache-Sitgreaves will increase at a rapid rate, as the state population doubles in 25 years and triples in 50 years.

Our Range Management Program is aimed at reducing people and livestock conflicts in high intensity use areas, as well as resolving conflicts between livestock and wildlife, in favor of wildlife. Most of these problem situations will involve riparian areas to some degree. We don't propose to approach these problems by necessarily excluding either use, but by changing management patterns that will satisfactorily separate the competing uses by time, space, or intensity of use. Particularly acute problems may and will demand the exclusion of one or the other use.

Current planning is underway to project a modest start into a much larger program for habitat improvement and reduction of conflicts between users of riparian areas. Direction through the recent Land Management Plan for the Apache-Sitgreaves National Forests calls for completion of an inventory in cooperation with the Arizona Game and Fish Department. We began this inventory in 1987 and will continue stream by stream, or on a priority basis, until complete. This is not to say that we will not take corrective measures until the inventory is complete. We are currently identifying problem livestock and riparian conflict areas, and will take action on resolving these conflicts according to our Land Management Plan. The Fish and Wildlife Program is accelerating at a fast pace, and we plan to continue this pace until our objectives for riparian areas are met.

You are well aware that the Forest Service is a Federal Land Management Agency and that we are required by law, as well as background and inclination, to practice multiple use management. This direction applies to our riparian areas, as well as to all other National Forest lands and waters. As a quick review, these are the products of Multiple Use: Recreation, Wildlife, Wood, Forage, and Water. While in total these are equally important, though not necessarily of equal value, all are common to riparian zones. Multiple use management does not require every acre to accommodate these uses equally, but we want to have the widest possible spectrum of uses commensurate with our "First Commandment", which is full protection for the basic resources of soil, water, and vegetation.

With reference to riparian areas, we recognize its high value for many uses, and that its limited size results in keen and sometimes bitter competition between users. Recognizing that multiple use management practically guarantees some conflict, we intend to manage the riparian zone to minimize these conflicts while accommodating as many uses as possible with no more than temporary impacts on soil, water, and vegetation. In dealing with grazing management on riparian areas, I think it would be unprofessional to automatically assume the total exclusion of livestock as the only answer to competition for use in riparian areas. Each problem is different. Usually an innovative grazing management system can provide for grazing with no detriment to other values.

To summarize, we must manage our riparian area with no impairment of their basic productivity. We don't have all the answers for managing riparian ecosystems, but we intend to be innovative in our management and "learn as we go".

As a way to begin change in the way we look at and manage riparian zones, the Apache-Sitgreaves is attempting to initiate a multiple use advisory committee, comprised of a broad cross-section of interests concerning National Forest management.

Issues such as management of riparian zones would be a prime topic for this committee.

We are implementing a concept called "Integrated Resource Management" which is defined as a land management philosophy which recognizes that all the natural resources are connected through an intricate series of interrelationships. If we generate an activity on one resource, we know that other resources will be affected. It's going to be our job, working together, to design the mix of uses such as fish and wildlife habitat in riparian zones, with or without livestock use, where the riparian zone is maintained or improved to meet our management objectives.

INSTREAM FLOW: RIGHTS AND PRIORITIES
A RATIONAL APPROACH

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Introduction

Rights to instream flow have been established by statute in many of the Western states. Arizona, however, has yet to enact such a statute. Most of the streams in the State are already fully subscribed by primary appropriators; and, until recently, the concept of an instream flow right has been unable to gain more than a toe-hold. By April, 1987, the Arizona Department of Water Resources (ADWR) had received only 31 applications for minimum instream flows. Of these, just two have been granted permits. Four are considered candidates for permit. The rest have been protested by other existing users.

Absent clear statutory direction, ADWR in November, 1986, established an interagency Instream Flow Task Force to assist the Department in its development of rules or guidelines for evaluating instream flow applications. The Task Force, of which the author was a member, surfaced various legal and technical issues related to instream flows.

Legal Issues

The legal issues revolving around instream flow rights include, among others, who may acquire an instream flow right, the type of stream which may be filed on, how the right is to be quantified, public access to the stream, interaction with other water rights, the priority date of the instream flow right, and surface water - groundwater relationships. Some believe that Arizona law regarding the permissibility of instream flow rights has been settled. Others believe that point is debatable.

The Salt River Project believes, in general, that water can be appropriated for instream flows so long as such appropriation is consistent with the Doctrine of Prior Appropriation and does not interfere with existing prior rights. The term "prior rights" includes the concepts of "amount," "location," and "type(s) of use." "Type(s) of use," in turn, embodies the concept that existing users have the right to continue, unimpaired, any reservoir operation and diversion practices employed to satisfy their rights to water or to meet any water delivery obligations they may have. Any instream flow rules eventually promulgated by ADWR must fully embody these concepts.

A major, and currently unresolved, issue in the granting of instream flow rights in Arizona is the interaction between surface water and groundwater. Adjacent pumping, either existing or future, may affect an instream flow. But, in Arizona, the uses of surface water and groundwater are governed by two separate laws founded on distinctly different legal doctrines. These differences lead to confusion and conflicting rights. The issue of surface water - groundwater interaction was heard by the Gila River Adjudication Court October 19-23, 1987, and will be resolved by that Courts' decision on the matter sometime next year.

Technical Issues

The ADWR interagency Instream Flow Task Force evaluated various methods for determining minimum instream flows. The Task Force's Instream Flow Biological Sub-Team recommended that ADWR categorize the State's streams into three levels based on the stream's aquatic resource values and related institutional considerations. The comprehensive Instream Flow Incremental Method (IFIM) would be used to evaluate Level I (high priority) streams. Level II (moderate priority) streams would be evaluated using a multiple transect method such as the R-2 Cross, the Fish Habitat Relationship System (FHRS), or Water Surface Profile (WSP). For Level III (low priority) streams, the Great Plains and/or a single transect method would be used. The recommendation has not been acted on by ADWR.

The IFIM recommended for Level I streams is data intensive and costly to implement. It is currently being used by the Bureau of Reclamation and Fish and Wildlife Service to evaluate minimum instream flows for the Verde River above Horseshoe Reservoir. Its credence will be the topic of the remainder of this paper.

IFIM - Fact or Fiction

Fish populations in a stream are affected by various physical (e.g. flow regime, habitat quality, water quality) and biological (e.g. food abundance and availability, predation, competition and interspecific interactions, migration, movement) factors. None of the methods currently available for evaluating instream flows adequately correlate these factors with biological reality. That is, they do not accurately predict changes in fish numbers or biomass resulting from changes in flow. This is especially true of the IFIM. Whittier and Miller (1986) note that stochastic events (such as Arizona streamflows) destroy the predictive accuracy of the IFIM model.

A growing volume of literature agrees that the weighted useable area (WUA) output of IFIM cannot be directly associated with fish biomass. The Wyoming Game and Fish Department performed comparative field tests of the different methods for evaluating instream flows. Their analyses indicate that IFIM is among the most inaccurate of instream flow methodologies for predicting fish biomass (Condor and Binns, 1986; Parsons and Hubert, 1986; Condor and Annear, Undated). Even the U.S. Fish and Wildlife Service (1984) recognizes that habitat output has no absolute meaning and that "WUA's... cannot be equated directly to characteristics of the fish populations." And the Canadian Department of Fisheries and Oceans in a review of eleven studies found that weighted useable area was in most cases not related to fish abundance or biomass. It reports that "This inconsistent relationship between fish biomass and WUA has two causes: 1) many implicit assumptions within PHABSIM are commonly not met in practice, and 2) weighted usable area, because it does not incorporate any aspect of an environment's productive capability, is an incomplete index of fish 'habitat'."

It is clear from the literature that IFIM is WUA sensitive, not biologically sensitive. The same applies to many of the other models available. Faust, et al. (undated) found in their review of 99 mathematical models which predict standing crop of stream fish that "sound statistical procedures were often overlooked or minimized during development of many models. Frequent problems were: too small a sample size, error in measuring habitat variables, choosing the best model, testing models, using models to predict standing crop, and assumptions in estimating standing crop. The major biological assumption that the fish population was limited by habitat rather than fishing mortality, interspecific competition, or predation was usually not addressed." Behnke (1987) terms the reliance on

models that fail to equate with biological reality "the illusion of technique."

To state the obvious: If a method for determining optimum - adequate - minimum instream flows were available that has withstood testing and validation, it would be accepted and used as the standard method by all states dealing with instream flow. But, no such standard exists. How then should Arizona proceed?

Recommended Approach

Unregulated streams in Arizona are characterized by extreme variations in annual, monthly, and daily flows. This hydrologic gyration is compounded further by local geologic, topographic and biologic conditions, making each stream essentially "unique." This uniqueness suggests the need for a case-by-case approach to evaluating instream flow requests. To meet this need, it is recommended that any guidelines developed by the State require clear definition of the applicant's objectives (goals) and the target species involved; and, furthermore, that the guidelines be directed towards the types of data required for ADWR's analysis (e.g. hydrologic data source, period of record, acceptable methods of analysis, target species, etc.). The applicant should be required to justify his instream flow claim with the techniques best suited to the particular conditions. Human knowledge and expertise (vs. computer model runs) provided by the applicant/ADWR/AG&F/USFWS should then be used to look for the simplest and most direct cause-and-effect relationship between flow and the target species that is amenable to quantification. For example, if a population of the threatened loach minnow is found to utilize a riffle area in a stream and, when flows drop below a critical level, the riffles are dewatered and the loach minnow population declines, then the critical flow necessary to maintain the riffle habitat must be determined. If a rainbow trout fishery depends on natural spawning, the spawning area should be studied. If the average depth of egg deposition is one foot, the question in need of an answer is: how much flow reduction causes depth to decrease below one foot in the spawning area, resulting in loss of incubating eggs? Critical habitat sites for particular species, such as side channels, undercut banks, etc. would need to be studied for each stream and then what flows would be too high or too low to maintain habitat quality determined.

This use of a goal directed approach should help focus the analysis required to properly evaluate the applicant's request. The three-tiered stream classification proposed by the Sub-Team would then not be required, saving unnecessary work.

Above all, it is recommended that Arizona not lock itself into use of "sophisticated" methodologies, but allow a range of methodologies to be applied under the guidance of expertise and common sense. The sophisticated methodologies all have flaws. They all fail to correlate with biologic reality. And, they all have to be selected and applied with reason and judgment to the situation for which they are best suited.

The factors of human judgment and knowledge should not be considered as weaknesses or be replaced with mere data and computer model outputs. Arizona should learn from its sister states and not succumb to the illusion of "knowledge" that reliance on models or methodology tends to create. Instead, critical thinking and reflective judgment should lead to the conclusion that no current instream flow methodology can be considered highly predictive and, therefore, should not be the final word for instream flow decision-making. Human judgment, knowledge and expertise are strengths which should be applied to instream flow evaluations - not laid aside in an attempt to cookbook those evaluations.

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PRESERVATION FLOW IN ARIZONA: THE CASE FOR LEGISLATION

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Introduction

Arizona has statutorily adopted the prior appropriation theory of water law described as "first in time, first in right." Unlike states which follow the riparian theory of water law where all users share the resources in common, a prior appropriator can dry up the entire stream by diverting it for irrigation or some other, state approved, beneficial use. Prior appropriation rewards water development but does not adequately provide for fish, wildlife or recreational needs.

There are 19 prior appropriation states which have traditionally required that three elements be present to perfect a water right: (1) water must be diverted, (2) with an intent to appropriate, (3) for a beneficial use as defined by statute. These three elements were thought necessary in order to prevent later appropriators from incorrectly relying on the assumption that water was available for appropriation. A preservation flow[1/] does not contemplate a diversion. The right sought is simply to have a minimum range of flows within a stream to preserve existing habitat for fish, wildlife and related recreational activities.

Current Status of Preservation Flows in Arizona

Arizona statutory law does expressly recognize appropriations for recreation, fish and wildlife,[2] but the Legislature has not acted to exempt these uses from the diversion requirement applicable to other appropriations. Moreover, the premise of a preservation flow that someone may have rights to the natural flow is a riparian concept. Arizona has rejected riparian law by its state constitution and by decisions of Arizona courts.

Arizona courts have not squarely faced a preservation flow claim and ruled on it. One decision, McClellan v. Jantzen,[3] does talk favorably about this concept but in fact it is not a preservation flow case. While McClellan v. Jantzen will be useful in a real preservation flow case because the court recognizes the concept of in situ appropriation, the future of threatened and endangered species, critical habitat of resident wildlife and recreational opportunities of the people of Arizona should not rest on the questionable interpretation of what one court said in dictum.

Despite the foregoing, in 1979 the Arizona Department of Water Resources (DWR), by administrative ruling, granted two preservation flows to the Nature Conservancy in Ramsey Canyon and O'Donnel Creek to maintain wildlife habitat.[4] These were the first such rights recognized in Arizona, and, to date, the only ones.

There are presently about 31 applications for preservation flows on file with the DWR. In an effort to process these applications, DWR has set up an interagency task force composed of professionals concerned with the future of preservation flows to suggest techniques for the evaluation of hydrological and biological factors and ultimately to develop rules or guidelines to manage preservation flows.

Arizona, New Mexico and Nevada are the only prior appropriation states which have not taken legislative action to protect its flowing streams. It is also significant to note that only Nevada has recognized the existence of a preservation flow without first enacting legislation defining and adopting the concept.[5] It seems doubtful that a successful preservation flow program can be undertaken in Arizona until authorizing legislation is passed and public policy is defined. Policy choices need to be made to determine whether any applicant, public or private, may obtain a preservation flow right; whether a preservation flow right is limited to recreation, fish and wildlife uses; whether such a right should be limited

to mountainous headwater streams or extended to the desert lowlands; and whether any applications should be considered before a study can be done and a plan developed.

Legislative Techniques Used To Recognize Preservation Flows

There are a number of strategies presently being used in other western states to recognize preservation flows by statute. These include: (1) legislative withdrawal or reservation of specific amounts of water in streams from further appropriation; (2) authority for administrative denial or conditioning of a permit to appropriate water when the appropriation would be contrary to the public interest; and (3) allowing a public agency, such as the Game and Fish Commission, to appropriate a quantity of water that is to remain in the water course for wildlife or recreational purposes.[6/]

Withdrawal or Reservation

One possible technique available to recognize preservation flows is through legislative withdrawal or reservation. Water in a natural water course can be removed from availability for some or all forms of appropriation by state action to preserve it for some future or present use. Some states withdraw specific rivers from appropriation to preserve them for scenic or recreational uses. Such legislation may allow administrative designation of protected waterways. Usually the purpose of such withdrawals is the furtherance of particular values, such as enhancement of fish and wildlife, recreation, aesthetics, or pollution control. At present there are 11 states that recognize some form of withdrawal or reservation scheme.[7/]

Denial or Conditioning of Appropriation Contrary to the Public Interest

A number of state statutes provide that the state's water rights administrator may not approve an application unless it is in the public interest; may condition appropriations so as to promote the public interest; or must deny an application contrary to the public interest. Public interest has historically been defined in terms of economic efficiency and protection of vested rights. Values such as fish and wildlife preservation, ecosystem maintenance and enhancement of

aesthetics generally have not been included in the public interest calculation. Today the definition of public interest is expanding to include environmental values. There are presently 13 states[8] that consider the public interest when appropriating water. However, only nine states[9] have used this language as a means of recognizing preservation flows. Arizona and New Mexico law provides that public interest be considered in granting applications to appropriate, but neither defines what public interest may include.

Appropriation by a Public Entity

What may be the best method of recognizing preservation flow is through the enactment of special legislation allowing a public entity to appropriate water for preservation flow purposes.[10] This approach does not attempt to get around the rights inherent in the appropriation system. Instead, the approach fits neatly into the State's existing permit system. This kind of legislation declares preservation flows for fish and wildlife purposes to be a beneficial use of water, and then eliminates the actual diversion requirement, since there is no longer any real purpose for requiring a diversion. Six states have adopted legislation which allows a public entity to appropriate a quantity of water that remains in the water course.[11] Only Nevada has recognized the appropriation of a preservation flow without the benefit of a statute.

Conclusion

Analysis of the experience of other states shows there are promising techniques for establishing preservation flows by legislation and concurrent administrative rules. Whatever strategy is chosen as the means of recognizing preservation flows, none can impair or diminish existing water rights as these are vested property rights. Any preservation flow will be a junior water right as to all existing appropriations on a stream.

The future of preservation flow claims depends upon the courts and the Legislature. Without legislative guidance, the court may reject the concept altogether. This unfortunate consequence can be avoided by legislation making the public policy choices.

ENDNOTES

1. The phrase "preservation flow" has been used interchangeably with other phrases including minimum flow and instream flow. The three phrases have been defined differently: "instream flow" - any use of stream flow that occurs within a stream channel and does not require diversion or impoundment; "minimum flow" - the lowest recorded discharge over a specified period of time; "preservation flow" - that range of flows within a stream required to preserve the existing levels of fish, wildlife, other aquatic organisms and related recreational activities. See Arnette, Nomenclature for Instream Assessments, Methodologies for the Determination of Stream Resource Flow Requirement: An Assessment (C. Stalnaker & J. Arnette, eds. 1976).

2. Ariz. Rev. Stat. Ann. § 45-141.A (1986).

3. Nevada v. Morros, No. 19404 and 19511 (Dist. Ct., Feb. 1987).

4. 26 Ariz. App. 223, 547 P.2d 494 (1976).

5. In the Matter of the Application for a Permit to Appropriate Public Waters of the State of Arizona, No. 33-78419 and No. 33-78421 (April 29, 1983).

6. See Attachment A: Techniques Used to Recognize Preservation Flows.

7. Oregon, Or. Rev. Stat. §§ 538.110-.300 (1983); California, Cal. Pub. Res. Code § 5093 et seq. (West Cum. Supp. 1981); Oklahoma, Okla. Stat. § 1451 et seq. (Cum. Supp. 1985); Washington, Wash. Rev. Code Ann. § 90.22.010 (Cum. Supp. 1981); Montana, Mont. Rev. Code Ann. § 85-2-316 (1983); Alaska, Alaska Stat. § 46.15.030 et seq. (1962); North Dakota, N.D. Cent. Code § 61-04-31 (Supp. 1983); Mississippi, Miss. Code Ann. § 51-3-7 (Supp. 1985); Kansas, Kan. Stat. § 82a-703a (Cum. Supp. 1985); South Dakota, S.D. Codified Laws § 46-2A-10 (1983); 1987 Hawaii Laws, Act 45.

8. Alaska, Alaska Const., art. VIII; Alaska Stat. § 46.15.080 (1985); Arizona, Ariz. Rev. Stat. Ann. § 45-143 (1986); California, Cal. Water Code § 1253 et seq.; Montana, Mont. Rev. Code Ann. § 85-2-316 (1983); New Mexico, N.M. Stat. Ann. § 72-5-7 (1978); North Dakota, N.D. Cent. Code § 61-04--6 (Supp. 1983); Oregon, Ore. Rev. Stat. §§ 538.110-.300 (1983); South Dakota, S.D. Codified Laws. § 46-1-6 (1983); Utah, Utah

Code Ann. § 73-3-8 (1980); Wyoming, Wyo. Const., art. 8, § 3; 1987 Hawaii Laws, Act 45; Kansas Stat. Ann. § 829-703b (Cum. Supp. 1984); Miss. Code Ann. § 51-3-7 (Supp. 1985).

9. Alaska, California, Hawaii, Kansas, Mississippi, Montana, North Dakota, Oregon and Utah.

10. Appropriation by private individuals would not seem to suit the best interest of the public since the benefit of instream uses run to the public. There have been only two appropriations made for instream uses, one by a private citizen and the other by a corporation: (1) A biologist in Washington applied for a permit to appropriate water for the purpose of propogating fish. Although he was originally denied the permit because no actual physical diversion was to be used, he later obtained the permit to appropriate the water. The Pollution Control Hearing Board of Washington stated: "Nor do we regard this application as in any sense the establishment of minimum flow by a private action." Comment, Minimum Streamflows: The Legislative Alternative, 57 Neb. L.Rev. 704, 726, n. 128 (1978); see also Trelease, Water Law Cases and Materials, 37-38 (3d ed. 1979). (2) In 1983 The Nature Conservancy, a private, nonprofit corporation devoted solely to the acquisition of ecologically significant lands, was granted the only two preservation flows that exist in the State of Arizona. In the Matter of Applications for a Permit to Appropriate Public Waters of the State of Arizona, No. 33-78419 and No. 33-78421 (April 29, 1983).

11. Colorado, Colo. Rev. Stat. § 37-92-103 (Cum. Supp. 1984); Idaho, Idaho Code § 42-113 (Supp. 1985); Nebraska, Neb. Rev. Stat. § 46-2, 107 (1983); Oregon, Or. Rev. Stat. §§ 536.325 (1983); Utah, Utah Code § 73-3-3 (1986); Wyoming, Wyo. Stat. §§ 41-3-1001 to 1014 (Supp. 1986).

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Attachment A

TECHNIQUES USED TO RECOGNIZE PRESERVATION FLOWS

There are three statutory means used by States to recognize preservation flows:
1) Appropriation by a public entity of a quantity of water that is to remain in the watercourse,
2) Legislative withdrawal or reservation of specific amounts of water in a stream from further appropriation, and
3) The denial or conditioning of a permit to appropriate water when the appropriation would be contrary to the public interest.

The following chart illustrates the States that recognize preservation flows and the means by which they recognize them.

STATE	APPROPRIATION	WITHDRAWAL OR RESERVATION	PUBLIC INTEREST / PERMIT CONDITIONING
ALASKA Protection of fish & wildlife habitat, migration& propogation; recreation & park purposes Alaska Stat. §46.15.145		**1980** -Any local, state, or federal government agency or any private person may apply to receive sufficient water to maintain an instream flow or level of water at a specific point on a stream or body of water, throughout a year or for specified times. **Alaska Stat. §46.15.145**	**1966** - One criteria for issuance of a permit is that the proposed appropriation is in the public interest, which includes the effect on fish and game resources and on public recreation activities. The Commission may condition permits to appropriate to protect existing rights & the public interest. **Alaska Stat. §46.15.080 et seq.**
CALIFORNIA Recreation& preservation and enhancement of fish & wildlife resources. Cal. Water Code §1243		**1972** -California Wild & Scenic Rivers Act: The State has designated over100 rivers & segments, which possess extraordinary scenic, recreational, fishery or wildlife to be preserved in their free flowing state together with their immediate environments for the benefit & enjoyment of the people of the state. **Cal. Pub. Res. Code §5093.50 et seq.**	**1956** -Administrator must deny an application not in the public interest. Board shall take into account the amounts of water required for recreation and the preservation and enhancement of fish and wildlife resources. The Board shall condition appropriations to best develop, conserve & utilize the water sought to be appropriated. **Cal. Water Code §1256, §1243 & §1253.**
COLORADO Recreational purposes, fish & wildlife, and minimum flows. Colo. Rev. Stat. §37-92-103	**1973** -Beneficial use shall also include the appropriation by the state of Colorado of such minimum flows between specific points or levels as required to preserve the natural environment to a reasonable degree. **Colo. Rev. Stat. § 37-92-103**		
HAWAII Maintenance of fish & wildlife habitat and ecosystems; recreational activities; aesthetic values. 1987 Hawaii Laws, Act 45		**1987** -The Commission on Water Resource Management shall establish instream flow standards on a stream-by-stream basis whenever necessary to protect the public interest in waters of the state. **1987 Hawaii Laws, Act 45**	**1987** - The Commission shall condition permits to protect instream flow. **1987 Hawaii Laws, Act 45**
IDAHO Recreation, fish, wildlife & aesthetic beauty. Idaho Code §42-1501	**1971** -Minimum streamflows are declared to be a beneficial use for the protection of fish and wildlife habitat, aquatic life, recreation, and aesthetic beauty, but can only be appropriated by the Idaho Water Resources Board. **Idaho Code §42-1501**		
KANSAS Recreation Kansas Stat. Ann. §82a-707		**1980** -Whenever the legislature identifies a minimum desirable streamflow the chief engineer shall withhold from appropriation that amount of water deemed necessary to establish and maintain a desired minimum streamflow. As of 1986 the legislature has established minimum stream flows on 18 streams or segments thereof. **Kansas Stat. §82a-703a**	**1980** -It is an express condition of each and every appropriation right that such right shall be subject to any minimum desirable streamflow requirements identified. **Kansas Stat. Ann. §82a-703b**
MISSISSIPPI Any useful purpose Miss. Code Ann. §51-3-3		**1978** -The Board of Water Commissioners can permit the appropriation of water of any stream, but only in excess of the established minimum flow. Exceptions may be made for domestic & municipal users. **Miss. Code Ann. §51-3-7**	**1978** -The Board may authorize an appropriator to use the established minimum flow upon written assurance that water will be immediately returned to the stream in substantially the same amount to insure the maintenance at all times of the average minimum flow. **Miss. Code Ann. §51-3-7**

STATE	APPROPRIATION	WITHDRAWAL OR RESERVATION	PUBLIC INTEREST / PERMIT CONDITIONING
MONTANA Fish, wildlife & recreational uses Mont. Rev. Code §85-2-102		**1973** -The State or any political subdivision or agency thereof or the U.S. or any agency thereof may apply to maintain a minimum flow level or quantity of water throughout the year or any such periods or length of time as the Board of Natural Resources & Conservation designates. The board may review, revoke, modify, or extend any reservation. **Mont. Rev. Code §85-2-316**	**1985** -Applicants for large water appropriations must show their project uses to be reasonable based upon needs to preserve stream flows for aquatic life. The Board may not adopt an order reserving water unless the applicant established that the reservation is in the public interest.The Board may limit a minimum flow to a maximum of 50% of the average annual flow. **Mont. Code Ann. § 85-2-316**
NEBRASKA Recreation, fish & wildlife Neb. Rev. Stat. §46-2,108	**1984** -An instream appropriation is considered a beneficial use and may be obtained only by the Nebraska Natural Resources Commission and only for that amount of water necessary for recreation or fish & wildlife. **Neb. Rev. Stat. §46-2, 107 et seq.**		
NEVADA Any recreational purpose Nev. Rev.Stat. §533.030	**1987** -Beneficial use is the basis of acquiring a water right in the State of Nevada. A diversion is not critical to an appropriative right. **Nevada v. Morros,** case no. 19404 and 19511, (Dist. Ct., Feb. 1987)		
NORTH DAKOTA Fish, wildlife and other outdoor recreational uses N.D.C.C. §61-04-01.1		**1977** -The State may reserve waters for beneficial utilization in the future. **N.D.C.C. §61-04-31**	**1983** -The State engineer shall issue a permit if he finds the proposed appropriations in the public interest. Public interest criteria include the effect on fish and game resources and public recreational opportunities. **N.D.C.C. §61-04-06**
OKLAHOMA		**1970** The Oklahoma Legislature finds that some of the free-flowing streams & rivers of the state possess unique natural scenic beauty, fish, wildlife and outdoor recreational values of benefit to the state.These areas are to be preserved for the benefit of the people of Oklahoma. **Okla. Stat. §1451 et seq.**	
OREGON Recreation, wildlife & fish life uses Ore. Rev. Stat. §536.300	**1983** -The Department of Environmental Quality or the State Department of Fish & Wildlife may submit to the Water Resources Commission applications for the establishment of minimum perennial stream flows. **Ore. Rev. Stat. §536. 325**	**1915** -When the Water Policy Review Board determines that it is in the public interest to conserve the water resources of this state for the maximum beneficial use and control, any unappropriated waters may be withdrawn from appropriation for all or any uses. Since 1915 over 15 named creeks, rivers and streams have been withdrawn from further appropriation. **Ore. Rev. Stat. §538.110 - .300**	**1955** -If the Water Policy Review Board finds that a proposed appropriation would impair or be detrimental to the public interest it shall reject the application or require its modification to conform to the public interest. The Board must give due regard to such public interest values as public recreation, protection of game fishing & wildlife and scenic attractions. **Ore. Rev. Stat. §537.170.**
SOUTH DAKOTA Any use of water consistent with the interests of the public S.D. Codified Laws § 46-1-6		**1983** -The State may reserve unappropriated water for future use so long as the quantity reserved will be needed and the proposed use is beneficial and in the public interest. **S.D.Codified Laws §46. 2A-10.**	**1983** -A permit may only be issued if there is reasonable probability that there is unappropriated water available, that the diversion will not impair existing rights and the proposed use is beneficial and in the public interest. **S.D.Codified Laws §46. 2A-9.**

STATE	APPROPRIATION	WITHDRAWAL OR RESERVATION	PUBLIC INTEREST / PERMIT CONDITIONING
UTAH Recreation, fish & wildlife Utah Code Ann. §73-3-8	1986 -The State Engineer and Division of Water Rights may change any existing water rights for the limited purpose of providing water for instream flows necessary for the propogation of fish. **Utah Code Ann. §73-3-3.**		1976 -The State Engineer may reject applications to appropriate water if it will unreasonably effect public recreation or the natural stream environment, or will prove detrimental to the public welfare. **Utah Code §73-3-8.**
WASHINGTON Protect fish, game, birds or other wildlife resources or recreation or aesthetic values Wash. Rev. Code §90.22.010.		1969 -The Department of Water Resources may establish minimum water flows or levels for the purpose of protecting fish, game, birds or other wildlife resources; or other recreational or aesthetic values whenever it appears to be in the public interest. The Department of Fisheries and the Game Commission may submit a request to establish minimum flows or levels. **Wash. Rev. Code §90.22.010**	
WYOMING To establish instream flows and to maintain new or existing fisheries. Wyo. Stat. §41-3-1001	1986 -No person other than the state of Wyoming shall own any instream water rights. Unappropriated water may be appropriated for instream flows to maintain or improve existing fisheries & is declared a beneficial use of water on a case by case basis if such use does not impair the rights of any other appropriators. **Wyo. Stat. §41-3-1001 et seq.**		1977 -No appropriation shall be denied except when such denial is demanded by the public interest. **Wyo. Const. art. 8 § 3**

Neither Arizona nor New Mexico have statutorily recognized preservation flows. In fact, the New Mexico Supreme Court has held that a man-made diversion is necessary to claim water rights by appropriation. State ex rel. S.E. Reynolds v. Miranda , 83 N.M. 443, 493 P.2d 409 (1972). However, Arizona and New Mexico have potential statutory means to protect instream values by denying applications to appropriate when it is contrary to the public interest. However, this technique can only be used if public interest is defined as including the protection of stream flow. Moreover, no state has relied solely on a public interest statute to recognize preservation flows. The public interest statute has always been used in conjunction with an appropriation or a withdrawal or reservation statute.

STATE	APPROPRIATION	WITHDRAWAL OR RESERVATION	PUBLIC INTEREST / PERMIT CONDITIONING
ARIZONA Recreation, fish & wildlife A.R.S. §45-141			1919 -The Director of the Department of Water Resources shall reject an application for appropriation when the proposed use is against the interests and welfare of the public. **A.R.S. §45-143**
NEW MEXICO Recreation & fish State v. Red River Valley Co., 51 N.M. 207, 182 P.2d 421(1945)			1907 -The State Engineer may refuse to consider or approve an application if in his opinion approval would be contrary to the public interest. **N.M. Stat. §72-5-7.**

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