

**ECONOMIC BENEFITS FROM  
INSTREAM FLOW IN A  
COLORADO MOUNTAIN STREAM**

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## ABSTRACT

Water flowing in streams has value for various types of recreationists. Increasing instream flows from low levels may enhance the recreational experience for fishermen, white water enthusiasts and shoreline recreationists. Increasing instream flows in arid and semi-arid conditions may be in conflict with established withdrawal uses, for irrigation, industries and households. Instream flows have a public or collective good character, such that market prices are not observable. Estimating marginal values for instream flow which are commensurate with those for withdrawal uses presents well-known difficulties.

Following recently developed techniques for estimating the value of public goods, an interactive bidding game was administered in 1978 to a sample of recreationists using a Colorado mountain stream to determine their willingness to pay for alternative rates of flow. Regression techniques were applied and the results were used to estimate the marginal value of instream flows for each month of the recreation season. The statistical reliability of the estimates was more than adequate, indicating the technique is suitable for aiding in instream flow management decisions.

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## CHAPTER 1

### INTRODUCTION

Farmers, mine operators, cities, and towns in Colorado have appropriated and developed the State's water resources since 1850. Unable to depend on rainfall in Colorado's semi-arid environment, they recognized that diverting water away from the natural stream channel would substantially increase their production possibilities. Even though withdrawal water uses (irrigation, household, and industrial) divert stream flow into the production of goods and services, many now believe that instream water uses (recreation and environmental quality) have an economic value large enough to warrant instream flow management strategies. However, major conflicts exist between withdrawal and instream water resources, since water in one capacity generally precludes its use in the other. This research first attempts to place an economic value on instream uses, then presents the economic and legal factors associated with different minimum flow management strategies.

Colorado's decision, early in its development as a state, to adopt water institutions that completely allocated water into crop production, mineral extraction, and domestic uses was economically wise. Instream flow water resources were abundant in relation to the amount farmers, miners, and towns could use. Stream recreation and aesthetic experiences were readily available compared with the urgent need and small supply of stream flow as production inputs. Diverting water flow away from the river transferred abundant water resources, having at the

margin only a small economic recreational value, into uses having a very large marginal value.

Many water resource planners still hold the belief that water in its natural state has no value, and resist any change away from the existing allocation institutions that are biased toward water resource development. Market forces direct water flow into withdrawal uses where the economic return to water is known and understood. Since outdoor water recreation developed as a non-marketed good, instream flow for recreation use is not subject to the same marginal prices as in withdrawal use, and appears as a free input in relation to other water uses. Granted, we may not want the market to allocate free-flowing stream recreation, but that doesn't mean instream water resources for that use have zero economic value.

Other individuals, even though they recognize water in the instream has value, often argue that economic analysis cannot possibly quantify the social value. The experience, generating personal and aesthetic pleasures, may be difficult to value, but the notion that economic value can't account for similar experiences is misleading. The economic market does a good job valuing a ticket to a Denver Bronco football game, which is primarily an aesthetic and recreation experience. Many marketed commodities have some degree of aesthetic value, which can be effectively reflected by market exchanges. This report takes the position that instream flow value for recreation is fully equivalent with the economic value of those resources in crop production. Due to the public good characteristic of instream flows, the job imputing non-market economic values is difficult but not impossible.

Because many individuals believe either water left instream has little value or economics cannot assist in determining recreation value, Colorado's water allocation system continues to distribute water into the production of goods and services, especially irrigated crop production. The part market-part legal water allocation has driven water's marginal value in crop production very low. At the same time, rapid population growth has increased water diversions for household and industrial activities. Future energy development might also require large water diversions. But equally important, growing income, leisure time, and mobility has broadened interest in instream flows for recreation. Instream flow provides direct utility to recreationists and indirect returns to Colorado's major tourist industry. How can resource managers satisfy all these water customers?

Colorado responded to these changing water demands by passing minimum flow legislation.<sup>1</sup> The federal government, also concerned about maintaining environmental instream flow benefits, responded with the Wild and Scenic River Act.<sup>2</sup> But, before governmental agencies can formulate appropriate stream flow management policies, they need defensible instream flow value estimates. Even though instream flow valuation may be difficult, rational and informed decision making requires specific and complete information about water's marginal value in all uses. This paper, focusing on instream flow valuation, should help the water resource manager answer questions concerning the optimal instream flow level.

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<sup>1</sup>Wayne Nelson, Gerry Horak, and Martin Lewis, "Instream Flow Strategies for Colorado," Fish and Wildlife Service, U.S. Department of the Interior, FWS/OBS-78/37 (May 1978), p. 12.

<sup>2</sup>Ibid., p. 25.

## Background

Even though withdrawal and instream users compete for water on most streams in Colorado, conflicts are especially evident in the Poudre River Canyon. As early as 1860, private companies began building irrigation canals providing water to land not adjacent to the Poudre River. The appropriation doctrine provided the framework to allocate water to irrigation companies. This legal institution allocates river flow by use and priority. Any individual with a beneficial water use (including household, irrigation, power, recreation, etc.) may apply for and receive a water right. Whenever appropriations on a stream exceed water supplies, each irrigator receives water based on his temporal priority. Farmers with senior water rights having the highest priority (earliest application date) divert water first, followed by junior irrigators having later application dates. This allocation system guarantees legal security to irrigators with senior water rights.

By 1900, irrigation companies and cities fully appropriated the stream flow in the study area, the Poudre River Canyon. Colorado water courts had decreed over 4,000 cubic feet per second direct flow rights to irrigators alone, even though the Poudre River seldom has instream flows exceeding 2,000 cfs.<sup>3</sup> None of the water rights have instream flow maintenance as their stated beneficial use. On any given summer day, irrigators could totally divert stream flows away from the Poudre River.

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<sup>3</sup>A. Maass and R. L. Anderson, ...And the Desert Shall Rejoice: Conflict, Growth, and Justice in Arid Environments (Cambridge, Mass.: MIT Press, 1978), p. 281.

Besides providing irrigation water, the Poudre River Canyon is an extremely attractive recreation site. During spring and early summer, certain river reaches form white water rapids that any kayaker or rafter can enjoy. By late summer, the stream flow drops low enough to support an excellent trout fishery. The National Forest Service even designated parts of the Poudre River as "wild trout" fishing sections for fly or lure fishermen. In addition, over 100,000 recreationists visited the Poudre Canyon to enjoy non-water contact activities, including camping, viewing, hiking, picnicking, etc.

Even though water allocation problems affect the entire Poudre River, they are especially troublesome throughout the lowest 30 stream miles where conflicts arise between recreationists, wanting the flow to remain instream, and farmers, diverting the water for crop production. The economic theory of optimal resource allocation supplies a framework for resolving these conflicts. The object is to distribute stream flow between competing users in order to produce the greatest social benefit. The operational criterion calls for reallocating stream flow until the marginal return in all uses is equal. Young and Gray<sup>4</sup> present substantial evidence on the marginal value of water in withdrawal uses. The research in this paper estimates the instream flow marginal value in the production of recreation and aesthetic experiences.

Although stream recreation obviously requires water flow, researchers have budgeted little time or effort into instream flow valuation. Instead, they have studied the instream flow requirements to sustain different levels of fishing, white water, or other

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<sup>4</sup>R. A. Young and S. L. Gray, Economic Value of Water: Concepts and Empirical Estimates, Final Report to the National Water Commission, Report No. NWC-SBS-72-047, March 1972.

free-flowing recreation, or they have ordinally ranked and quantified streams and stream recreation.<sup>5,6</sup> An extensive literature search didn't reveal any published study that unequivocally places an economic value on instream flow commensurate with values generated by more familiar market mechanisms.

The recent economic studies valuating different environmental improvements provides theoretical direction. In 1974, Randall, et al.<sup>7</sup> estimated the economic benefits from air quality improvements in the Four Corners Region (southwestern United States). Brookshire, et al.,<sup>8</sup> following Randall's study, placed an economic value on aesthetic damages from additional coal-fired power plants in the Four Corners Region. Hammack and Brown,<sup>9</sup> later Randall and Brookshire,<sup>10</sup> established economic values for wildlife in a recreational experience. Although these studies impute synthetic resource values, they deal with substantially different environmental problems. The most relevant

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<sup>5</sup>Ronald Hyra, Methods of Assessing Instream Flows for Recreation, Instream Flow Information Paper No. 6, Cooperative Instream Flow Service Group, Fort Collins, Colorado, June 1978.

<sup>6</sup>E. L. Michalson, "An Attempt to Quantify the Esthetics of Wild and Scenic Rivers in Idaho," River Recreation Management and Research Symposium, USDA, Forest Service, January 1977.

<sup>7</sup>Alan Randall, Berry Ives, and Clyde Eastman, "Bidding Games for Valuation of Aesthetic Environmental Improvements," Journal of Environmental Economics and Management (1974).

<sup>8</sup>David S. Brookshire, Berry C. Ives, and William D. Schulze, "The Valuation of Aesthetic Preferences," Journal of Environmental Economics and Management (1976).

<sup>9</sup>Judd Hammack and Gardner Brown, Waterfowl and Wetlands: Toward Bioeconomic Analysis, Resources For The Future (Baltimore: Johns Hopkins University Press, 1974).

<sup>10</sup>Alan Randall and David S. Brookshire, "Public Policy, Public Goods and Contingent Valuation Mechanisms," Staff Paper 68, University of Kentucky, Lexington, June 1978.



study valued water quality improvements in the South Platte River Basin, Colorado.<sup>11</sup>

### Objectives

This research paper has two major objectives. Following the recent advances in environmental economics valuing air, water, and wildlife inputs into aesthetic experiences, the first objective is to estimate instream flow's marginal value for water-based recreation. As with the other environmental resources, instream flows have public good attributes that discourage private market allocation systems. In the absence of market prices, this paper inputs synthetic instream flow social values comparable and commensurate with those values in withdrawal uses.

The amount a recreationist is willing to pay for alternative flow levels represents instream flow's economic value. Stream recreation may depend on water flows, but decisions concerning resource allocations involve adding or subtracting small increments to the existing flow level. Regardless of the large aggregate value many individuals assign to stream recreation experiences, each person has a limit on how much they will give up to enjoy small additions to the instream flow. The appropriate decision-making value, corresponding to ones in the market economy, is the marginal willingness to pay for instream flows.

The second objective is to present the economic and legal factors associated with developing minimum flow strategies. For years, water allocation institutions encouraged diverting water from the stream into

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<sup>11</sup>Richard G. Walsh, Douglas A. Greenley, Robert A. Young, John R. McKean, and Anthony A. Prato, Option Values, Preservation Values and Recreational Benefits of Improved Water Quality, U.S. Environmental Protection Agency, January 1978.

crop production or household use. Today, many Coloradoans are willing to sacrifice traditional water use outputs for more recreation amenities. Complete evaluation of decisions, changing instream flow levels, requires analyzing the economic tradeoffs associated with alternative instream flow allocations and the legal institutions structuring water right distributions.

Economic theory, alone, may lead to inappropriate minimum flow strategies unless the policy maker considers the legal regulations. How can water planners allocate instream flow between conflicting needs to produce the greatest social benefits becomes the economic question. Ignoring any intemporal problems, the traditional static rule for social benefit optimization calls for an allocation where the instream flow marginal return in all uses is the same.<sup>12</sup> But, economic solutions interact with the legal water rights regulations. Various water right laws may lead to different actual water allocations and different perceptions about the optimal water allocation.<sup>13</sup> Looking only at the economic concepts and information clarifies many issues, but unnecessarily limits any policy recommendations.

### Procedures

This research uses a contingent valuation approach (direct consumer surplus technique) to estimate the recreationist's willingness to pay for instream flows. The inverse demand function is:

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<sup>12</sup>J. Hirshleifer, J. C. DeHaven and J. W. Milliman, Water Supply (Chicago: University of Chicago Press, 1960).

<sup>13</sup>D. W. Bromley, "Property Rules, Liability Rules, and Environmental Economics," Journal of Economic Issues, Vol. 12, No. 1 (March 1978).