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FINAL REPORT

UPPER GUNNISON BASIN IN-STREAM FLOW PROJECT

by

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See M. Wilcox and J Harte (1997) Ecosystem Services In A Modern Economy: Gunnison County, Colorado in Nature's Services. Societal Dependence on Natural Ecosystems (G Daily, Ed.) Island Press, Washington, D.C., pp. 311-328

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1. INTRODUCTION AND SUMMARY

This is the final report for a project funded by the Ford Foundation, the purpose of which was to measure the value of the water flows in, and the habitats affected by water flows in the East and the Taylor Rivers near Gunnison, Colorado. Motivation for the study arose from public controversy over the proposed transmountain diversion of water from these streams to municipalities near Denver.

The main goal of the study was to estimate a total uncompensated value of resource services lost if water flowing in the upper Gunnison River were diverted by one of two proposed projects. Estimated values include both market and non-market values.

Market values attach to uses of water for which market prices provide a reasonable estimate. These include hydroelectric power generation, salt water dilution in the Colorado River, and the opportunity cost of water supplies to metropolitan users in California. James Booker's 1990 PhD dissertation furnishes most estimates of market values.

Non-market values are divided into active use and passive use values. Active use values are those derived from recreational activities such as white water boating and angling. Surveys of these two user groups were conducted by David Harpman during the summer of 1989, and were the subject of his PhD dissertation.

Passive use values are those derived from existence, option, and bequest values. A contingent valuation survey was mailed to a representative sample of Colorado families in late summer and fall of 1990. A commercial market research firm, National Family Opinion Research, Inc.(NFO), was used. NFO sent questionnaire's to 1400 of their Colorado panel members with a return rate of over 67%.

The values estimated for instream flows are summarized in table 1.1 below. Methods used to derive these estimates are developed in the text of the report and its appendices. It should be noted at the outset that recreational uses--especially fishing-show relatively small effects. The fishing study found that, since winter flows would be little affected by either proposed project, the effects on fish harvest are likely to be negligible. White water boating is surely affected--and if the $16 per acre foot cost were capitalized, it amounts to an additional $15 million.

Note, however, that this value is far outstripped by the willingness of Coloradans to pay to preserve the areas which would be affected by the projects: over $300,000,000 in the case of each project (assuming a 7.5% discount rate). That comes down to about the same thing as $20,000,000 per year for the Collegiate Range project and $25,400.000 per year for the Union Park project. While the figures are large by most common reckoning, they are somewhat less than $10 per year for each Coloradan. Note too, that the market value of water passed on to California is on the same order.

It is difficult to escape the conclusion that there is potential for some widely acceptable alternative to further transmountain water supplies. Between the economic value of water flowing to California and the value Coloradans place on preserving their mountain amenities, there is a substantial potential for funding alternatives.

TABLE 1.1 Summary of Estimated Uncompensated Costs Associated with Exporting Water from the Taylor River	
MARKET VALUE Hydro Electric Power Calif Municipal Demand TOTAL MARKET VALUE	 $67.17/acre ft $390.00/acre ft $457.17/acre ft
NON-MARKET VALUE White water boating Angling--Taylor River Preservation value TOTAL NON-MARKET VALUE:	 $16.18/acre ft $1.43*/acre ft $332 to $436/ acre ft (Coll. Range) $363 to $465/ acre ft (Union Park) $350 to $454/ acre ft (Coll. Range) $381 to $483/ acre ft (Union Park)
TOTAL UNCOMPENSATED VALUE:	$838 to $940/acre ft (UNION PARK) $807 to $911/acre ft (COLL. RANGE)

The Valuation Problem

Valuation of water flowing in streams of Colorado poses both legal and econometric difficulties. On the legal side, there is Colorado water law which still does not recognize public values of water. Colorado's legal tradition defines water as having a value only when it is withdrawn from a stream and put to beneficial use...a measure of value even more restrictive than market value.

This runs counter to the steady growth of public concern for environmental amenities. In Colorado's mountains, environmental amenities are inextricably linked to mountain streams. There is need for new law or new interpretations of old laws to bring water law into line with the public will.

The evolution of the "public trust" legal doctrine seems to be a step in this direction. Loosely speaking, the public trust represents the property right to the public good value of unappropriated water rights, and it is therefore necessarily exercised and enforced by government.

For economists, the problem is to present evidence that in-stream flows have significant inherent values. The difficulty of this assignment lies in the fact that the economic value of in-stream flows incorporates both market and non-market values. While market values are usually easy to infer from market prices, non-market values require expensive and somewhat controversial techniques called contingent valuation (CV).

The Upper Gunnison Case

Impetus for this study arose through High Country Citizens' Alliance (HCCA), a cross-section of citizens from the Gunnison County area, concerned with preservation of their community and its ambience. HCCA has served as a focal point for local concern over two proposals to export water from the basin.

These projects include the appropriation, storage and the trans-mountain diversion of a significant portion of the annual flow of either the Taylor River or the East River as measured near their confluence near Almont, Colorado. At Almont the rivers become the Gunnison River which flows into the Blue Mesa Reservoir near Gunnison.

Many residents view the projects as threats to their livelihoods or to the beauty of their region. They argue that Coloradans outside their region share an interest in preserving the free flowing nature of their streams--and that these interests should be taken into account as the project proposals are considered.

The objective of this study is to valuate benefits which would be lost but uncompensated if either of the projects were built. That includes in-stream flows of the upper Gunnison Basin and the environmental amenities of sites affected by construction of the project. In particular, we focus on those values of in-stream flow which are most easily measurable: market values of water use downstream from the upper Gunnison Basin, direct use values of white water boaters and fishermen, preservation values attached to affected areas by Coloradans in general.

The net being cast is a conservative one. It does not include real costs to other uncompensated parties. These include, among others, property owners near affected rivers, anglers using Taylor Reservoir, hunters using Union Park, and campers who use campgrounds along the Taylor River. Nor does it account for potential job loses if agricultural water is sold in the transfer.

The Study Area

The Upper Gunnison River Basin[1] is located in Gunnison County, Colorado--approximately 200 miles to the Southwest of the Denver metropolitan area. This region is noted for its natural beauty and for being relatively undeveloped.

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1 For the purposes of this study the Upper Gunnison River Basin is defined as the area drained by the Gunnison River above the Blue Mesa Reservoir.

Historically, the economy of the region has been heavily dependent on the agriculture, mining, and timber industries. These traditional industries are in decline and have been largely supplanted by growth in the recreation industry. In particular there is a large and growing use of the rivers in the basin for fishing and for white water rafting.

East River

The East River drainage starts south of the Elk Mountains. Along its headwaters is Gothic, the site of the venerable Rocky Mountain Biological Laboratory, and Crested Butte. The East River then flows south to Almont where it joins with Taylor River to form the Gunnison River.

The Roaring Judy Fish Hatchery is located on the East River near Almont. The Colorado Division of Wildlife considers this hatchery to be unique because of its natural spring water supply. In addition, the hatchery is the destination of a salmon migration. During the fall of 1989, fishermen caught 50,000 pounds of salmon during the migration. The migration has attracted a bald eagle migration--25 birds were counted along the salmon migration during Fall, 1989.

Taylor River

The Taylor River headwaters lie in the south eastern part of the Elk Mountains and the western part of the Sawatch Range. The river flows south into Taylor Park and Taylor Reservoir. Below the reservoir, Taylor River flows southwest through a forested canyon to Almont where it joins the East River.

The Taylor Park area, at 9,300 feet, is home to historic Tin Cup--a ghost mining town. A resort is located near the high water mark of Taylor Reservoir. Thousands of vacationers visit Taylor park each year for fishing, hunting, boating, waterskiing, and windsurfing. Taylor Reservoir supports a population of lake trout. While not numerous, these fish attract considerable attention from anglers because they grow to very large size.

The stretch of Taylor River Between Taylor Reservoir and Almont is the site of forest service campgrounds, resorts, white water boating, angling, and numerous private residences. This area is noted for its scenic beauty and attracts large numbers of recreators from summer through early fall.

Union Park

Union Park is a high mountain valley situated on a plateau just south of Taylor Reservoir. Its remoteness and abundant water supplies support prolific wildlife as well as summer pasture for cattle. The area includes three known calving grounds used by a herd of 1500 elk. It is an area well known to elk hunters.

Almont Triangle

The triangle northeast of the angle made by the Taylor and East Rivers is considered a sensitive wildlife habitat. It includes wintering grounds for one of the few remaining native bighorn sheep herds. The herd is successful enough that it is used by the Colorado Division of Wildlife as a source of stock for planting in other parts of the state.

Proposed Projects

Two major water development projects have been proposed within the Basin. These are: the Collegiate Range Project and the Union Park Project (Colorado Water Resources and Power Development Authority 1988c). The proposers of these projects plan to appropriate, store, and divert approximately 60,000 acre feet of water annually to Colorado's Front Range. This proposed diversion represents 27% of the average annual flow[2] of the Taylor River as measured at the Almont gauging station.

These proposed transbasin diversion projects are likely to reduce the viability of the white water rafting industry, adversely impact recreational fishing, reduce the water available for agriculture, and, preclude other forms of economic development within the basin. In addition, construction of new reservoirs would cover of the area with water--3,500 acres in the case of Union Park and 6.4 miles of river in the case of the Collegiate Range project.

The area inundated with the Collegiate Range project includes the Roaring Judy Fish hatchery--considered by the Colorado Division of Wildlife to be "irreplaceable." Construction of Almont reservoir would be adjacent to the Almont triangle, running the risk of disturbing habitat of the native bighorn sheep herd in that area.

The Union Park Project would inundate 3,500 acres of Union Park, including elk calving grounds. Diversion of waters to fill that reservoir could come from as far

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2 Calculated from U.S. Geological Survey Hydrographic records for the period 1952 - 1983.

away as Gothic, site of the world renown Rocky Mountain Biological Laboratory, running a risk of depreciating the value of that site for scientific research.

Valuation of Uncompensated Costs

Benefits from the proposed projects are not trivial. Either project would supply enough water to the Front Range to support about 250,000 new residents. There is also the possibility that a pumped storage electrical generating station could be a part of the Union Park Project, possibly reducing the cost of electricity to Coloradans.

Against these benefits must be weighed costs of the project--both those paid directly by project owners and those not compensated. The following four sections detail the procedures and results of our estimation of an important part of the uncompensated costs of either of the projects. Section 2 deals with the conceptual issues involved in estimating uncompensated costs of projects such as these. Section 3 estimates values of market goods lost, section 4 estimates values of active user benefits lost, and section 5 presents estimates the preservation or 'passive use' benefits lost.

Uncompensated values of water diverted from the upper Gunnison to Colorado's Front Range was conservatively estimated to be approximately $800 per acre foot for the Collegiate Range project, and $850 per acre foot for the Union Park Project. Of these values, about $460 accrues to lower basin states--principally California. Thus, the uncompensated effects accruing to Coloradans are about $340 for Collegiate Range, and $390 for Union Park. See table 6.1 for more details.

2. GENERAL DISCUSSION OF VALUATION TECHNIQUES

Uncompensated costs of the proposed projects have been partitioned into market and non-market costs. The basic idea of estimating market costs is straight forward and will not be discussed apart from section 3. Non-market values are another matter.

This study has employed three contingent valuation studies in estimating non-market values of in-stream flows. Since contingent valuation has been the subject of recent controversy, some background on the basic ideas of contingent valuation and the issues being argued in the environmental economics literature is warranted. A more comprehensive treatment is found in Appendix 1 which deals at length with contingent valuation and passive use value.

Origin of Contingent Valuation (CV)

During the 1960's and 1970's economists struggled with definitions of value for non market goods. The concept of 'willingness to pay' emerged as a promising link between public sentiments and comparison of alternatives in public decision making when alternative involve non-market goods.

It is fair to say that there is widespread agreement among environmental economists that public goods' services have a value theoretically equal to a sum of the values everyone would be willing to pay for that service. Disagreement arises from attempts to measure that willingness to pay.

The 1980's spawned numerous attempts to measure willingness to pay for non market goods. By the late 1980's a dominant method seemed to have emerged:

contingent valuation (CV). This amounts to asking people to state the maximum amount they would be willing to pay for a particular public good rather than go without it.

Such questions could result in strategic answers since the respondent knows that they will not really have to pay, and that their answer may have an inordinate effect on the ultimate decision. Refinements of the method have led to better ways of asking questions, for example dichotomous choice where the respondent simply replies yes or no to a particular sum.

Detractors of CV contended that respondents give answers that are inconsistent with rational choice as defined in economics. Moreover, they contend that respondents do not understand the questions they are being asked to answer, and that respondents need not take answers seriously because they need not actually pay what they say they are willing to pay.

Economists and public officials take these charges seriously because CV has become the only practical method to measure values of public goods and therefore crucial to both courts and legislatures.

The NOAA Panel Criteria

Consequently, the National Oceanic and Atmospheric Administration commissioned a study by a Resources for the Future panel. The panel consisted of a distinguished set of economists--including two Nobel Prize recipients. CV received a qualified vote of confidence.

> "The panel concludes that under those conditions (and others specified [below]), CV studies convey useful information. We think it is fair to

describe such information as reliable by the standards that seem to be implicit in similar contexts, like market analysis for new and innovative products and the assessment of other damages normally allowed in court proceedings." Arrow, et al, (1993), pp 41-42.

The panel listed a set of guidelines which would define an ideal CV survey. These guidelines are briefly discussed here so that the methods used in this study can be evaluated against these criteria in sections 4 and 5.

Use of probability based sampling techniques Samples drawn in many studies use convenient populations, such as those around a college campus, thus missing a representative cross section.

High response rates Very low response rates will generally frustrate even a well designed sample, and result in non-representative responses.

Interview format Use of mail surveys is discouraged because respondents are free to preexamine the survey and decide not to answer on the basis of interest.

Careful pretesting of questionnaires Questions on natural resource CV studies are often fairly technical in nature and require understanding. Complicated questions will usually get a large proportion of non-sense answers.

Conservative design When aspects of the survey are ambiguous, the option that underestimates willingness to pay should be chosen. This increases the reliability of the method by eliminating extreme responses.

Use of a referendum format Posing valuation questions as votes on referenda can avoid giving respondents an unusually difficult task of placing a maximum amount they would pay for a public good. The alternative of giving a price range is seen as creating problems of anchoring--suggesting 'appropriate' answers.

Accurate description of alternatives This may impose a very difficult task if it is taken too literally. But it is necessary to present respondents with at least as much understanding as they would be likely to have if they were really voting on a tax referendum.

Pretesting of photographs. Photographs are effective in getting attention, but may also serve to evoke too much emotion and thereby detract from other information.

Reminder of substitute commodities Respondents should be aware of other natural resource services or should be informed of the possible future state of the resource in question.

No answer option A 'Don't know' option should be available, in addition to the yes/no alternatives.

Yes/no followups Respondents should be asked why they answered yes or no. This may reveal reasons for discarding their answers as not reflective of the value they attach to the resource.

Checks on understanding Inconsistencies in answers can be used to eliminate respondents who did not understand the information presented.

Alternative expenditure possibilities Respondents should be reminded to imagine their bid as coming at the expense of their own budgets. Use of some plausible payment vehicle such as a tax or a utility bill can serve to remind respondents that their willingness to pay for the environmental good would reduce their expenditures on other goods.

Arrow et al make it clear that these criteria are 'ideal,' and that failure to meet some of them does not render CV information useless. It will become clear that the three CV studies satisfy a significant portion of the ideal criteria.

3. MARKET VALUES OF IN-STREAM FLOWS

If water is exported from the upper Gunnison Basin to Colorado's front range, and if this water is newly developed water, then it will result in a reduction of flows in the upper Gunnison and in every reach down to Lake Havasu in California. Had these flows taken place they would generate goods with market values in a number of ways. The most significant of these are hydropower and municipal use in southern California. Salinity is often treated as a separate factor, but dilution of salinity mostly benefits urban users.

Each of these is taken in turn, and an opportunity cost is developed. The total of the three opportunity costs is a conservative estimate of the uncompensated market costs of diverting water from the Upper Gunnison to the front range.

Hydroelectric Power Generation

Electric power generation from water in the upper Gunnison comes from plants at the Aspinal Unit (Blue Mesa Reservoir, Morrow Point, and Crystal), Glenn Canyon, and Hoover Dam. Using Booker's figures, the production of electricity is assumed to be 616 kwh/af at Glenn Canyon and 724 kwh/af at Hoover Dam. Using figures from USBR(1990) and USFW(1992), the production at the Aspinal Unit on the Gunnison

River is assumed to be 720 kwh/af. Thus water originating in the upper Gunnison can be expected to generate approximately 2060 kwh/af on its way to Lake Havasu.

The value of this hydropower cannot be estimated by investigating market transactions. Most sales are fixed at very favorable rates in long term contracts with the Bureau of Reclamation. The proper measure of the market value of this power is the costs avoided by utilities in substituting hydropower.

Booker (1991) has calculated these costs as the operation and maintenance of alternative electrical generation capacity minus the operation and maintenance costs of hydropower. Booker uses the capacity weighted average of the most costly 50% of total capacity to determine savings from use of hydropower..reasoning that this is the excess capacity that would have to be used to replace hydropower.

If, in the future, there is no longer excess generating capacity in the western power grid, the opportunity cost of the hydropower would have to include the capital cost of capacity as well as operation and maintenance costs. Since Booker's figures assume there is excess capacity, they are conservative.

Costs of transmission and costs of alternative generation differ between upper basin (Glenn Canyon and Aspinal Unit) and lower basin (primarily Hoover Dam). Booker's estimate of the opportunity cost of power in the lower basin is 47.8 mils/kwh and for the upper basin is 24.4 mils/kwh.

If we multiply the 47.8 mils times the 724 kwh/af at Hoover dam, and the 24.4 mils times the combined 1444 kwh/af for the combined Glenn Canyon and Aspinal Units, we have a total of $34.07 per acre ft in the lower basin and $35.23 per acre ft in the upper basin for a total of $69.84 in hydropower costs per acre ft of water diverted from the upper Gunnison to the Front Range.

Booker shows about 27% of Glenn Canyon power going to Colorado. Although we do not have figures, it safe to assume that a much high proportion of the Aspinal Unit's power goes to Colorado.

Value of Municipal Water in Southern California

Booker (1991) develops an opportunity cost of Colorado River water delivered to Southern California by estimating a demand function for municipal water, then backing out delivery costs from Lake Havasu($91), treatment costs($33), and damages from salinity($100).

Adjusting for growth of population to 1990 level, Booker estimates the value of a marginal water delivery at Lake Havasu to be $290.

The salinity cost of Colorado River Water is the cost of damages done by the water at a given level of salinity. Decreasing the flow of fresh water into to Colorado from the Gunnison would cause a higher level of salinity and therefore a higher level of damages per acre foot of Colorado water. Since only a fraction of the Colorado River water goes to municipal users, the dilution value needs to be spread out over water which goes to agricultural uses. Consequently, dilution should at least the value to the share of the water that goes to municipal purposes--this is set at 25%, or $25.00.

4. ESTIMATING ACTIVE USE VALUES OF IN-STREAM FLOWS

Two groups of recreational users were surveyed for this study--anglers on the Taylor River between Almont and Taylor Reservoir, and white water boaters on the same stretch of Taylor River and the stretch of the Gunnison River between Almont and Gunnison.

The Taylor River Fishery--Public and Private

An interesting feature of the Taylor River below Almont Reservoir is the existence of substantial privately owned fishery. The owners have been paid large sums to obtain exclusive rights to the fishery, and, subsequently, to hire lawyers to preserve the flows in the Taylor River.

Apparently, Owners of the private fishing reserves seemed convinced that the effects of the proposed project would have devastating effects on the fishery. In fact, the demonstrated willingness of these few land owners to pay for the preservation of flow is uncontestable evidence of a market value of in-stream flows.

The work done for this study did not take these transactions into account. Rather, a substantial effort was mounted to determine first the effect of in-stream flows on fish habitat, then the effect of habitat on population, and finally, the value of fish population to anglers. The method used set a new standard for rigor in economic valuation of in-stream flow for fisheries. Surprisingly, results seem to indicate that the effects of the Collegiate Range project on the fishery would be mixed, and negligible. Details of the study can be found in Harpman's PhD dissertation, in Harpman et al (1993), and in Appendix 2.

Description of Area Hydrology

Average precipitation ranges from approximately 10.5 inches in Gunnison to 27.03 inches in Crested Butte (County Information Service 1989). Short intense thunderstorms characterize summer weather, but most precipitation is winter snow.

Average snowfall ranges from 49 inches in Gunnison to 209 inches in Crested Butte (County Information Services 1989). Cold winters assure very little snowmelt until spring. Stream hydrology is thus characterized by minimal winter flows and extremely high spring flows.

Figure 4.1 illustrates the mean flow patterns (calculated from U.S.G.S. records at Almont, CO. for the period 1975-1988) which characterize the streams within the study area.

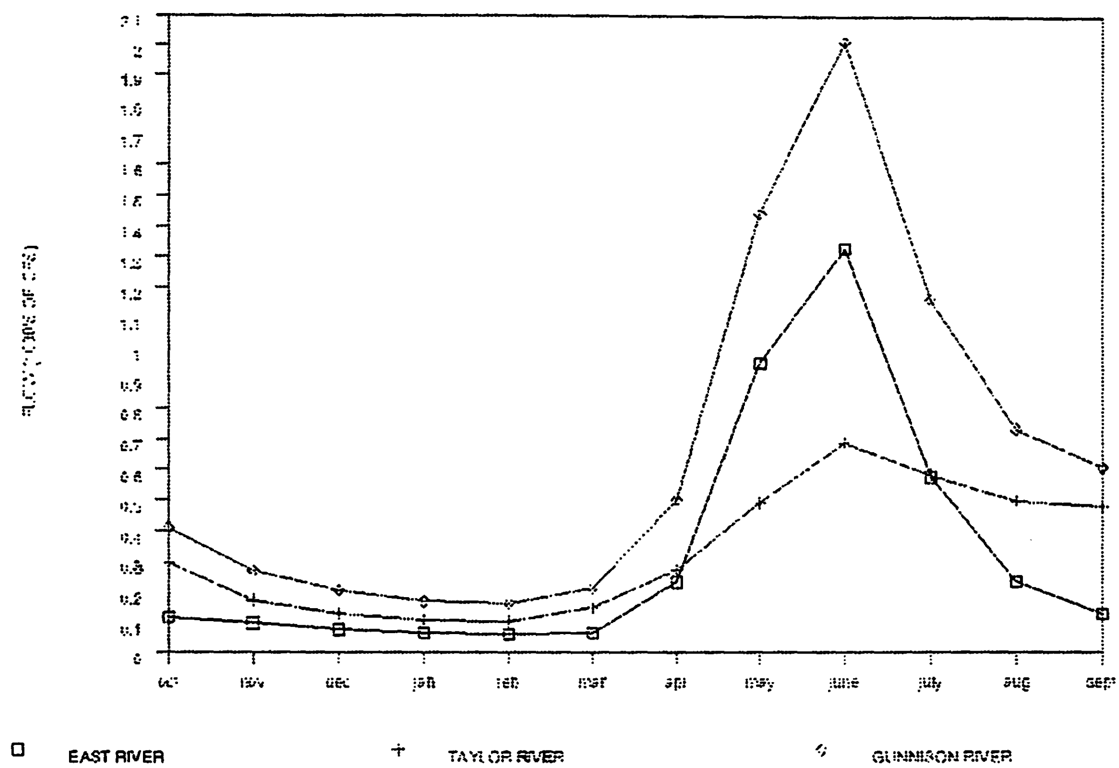

Figure 4.1 Mean Monthly Flow 1975-1988 of the Taylor River, the East River, and the Gunnison River at Almont, Colorado.

The East River and the Taylor River have roughly the same mean annual flows, but East River flows are uncontrolled while Taylor River flows are controlled by the 106,200 acre foot Taylor Park Reservoir. This buffering effect causes mean winter flows in the Taylor River to be higher than those in the East River and mean spring flows to be lower.

Although Taylor Reservoir was built in 1937, it was not always managed in a way that moderated flows in the Taylor River. Taylor Reservoir water is owned by the Uncompahgre Valley Water Users Association whose water rights are among the most senior in Colorado. This reservoir was originally constructed and operated to provide storage for downstream irrigation needs. When the irrigation season was over, releases from the reservoir were sharply curtailed. When operated in this fashion the mean winter flows in the Taylor River were very low and came primarily from small tributaries below the dam.

Completion of much larger Blue Mesa Reservoir on the Gunnison River allowed for a more flexible release pattern. In 1975 the Colorado Division of Wildlife and the Uncompahgre Valley Water Users Association reached an agreement to maintain winter flows in the Taylor River at 50 cfs.

The purposes of this agreement were two-fold. First, the agreement provided a mechanism to maintain winter habitat flows. This improved the winter survival of fish in the Taylor River. Second, the agreement allowed spawning flows to be stabilized[3] thereby improving the spawning success of fall spawning species such as brown trout.

3Brown trout typically spawn in September-October. If flows fall after these fish have spawned, areas where they have spawned may be de-watered or may suffer subsequent ice damage. When this occurs, the eggs and young fish present in the reeds are killed.

Description of the Fishery Resource

The recreational fishery in the Taylor River is composed mostly of Brown trout, Salmo trutta, and Rainbow trout, Salmo gairdneri. Rainbow trout do not spawn in the Taylor River and must be restocked each year. Approximately 8,603 rainbows were stocked in the Taylor River below the Taylor Park Reservoir by the Colorado Division of Wildlife in 1988, and 13,640 in 1989 (Hebein 1990). Somewhere between 29% (Colorado Water Resources and Power Development Authority 1988a) and 60% (Hebein 1990) of the stocked rainbows are creeled and the remainder apparently die of natural causes.

The lower reach of the Taylor River is fed by the Taylor Park Reservoir. This reservoir buffers the flows in this reach so that there is less variation than on an uncontrolled river. Taylor Reservoir design dictates that water is released from the bottom of the dam. These releases are cold and nutrient deficient. Consequently, the trout in this reach grow very slowly (Colorado Water Resources and Power Development Authority 1988a, page 7-14).

The most recent fisherman count and creel census was conducted on the Taylor River in the summers of 1981 and 1982 (Colorado Water Resources and Power Development Authority 1988a, page 7-15). In 1981, it was estimated that approximately 382 angler days per mile, or 8,100 anglers days were spent on the lower Taylor River. There have been no subsequent attempts to systematically estimate angling use.

Unfortunately, there are no detailed records of angling use available for the study area which are comparable to white water boating use records. In lieu of such data, several local experts were consulted (Tom Spezze 1989, Mike Turner 1989). These experts were asked to allocate the total fishing pressure over a one year period. Their responses indicated that the vast majority of angling use occurred in the months of July and August. Again, this corresponds to the period when most Americans take their annual summer vacations.

Angling use during the week seems to follow a pattern similar to that of white water boating. More angling occurred during mid-week and less on weekends. However, the difference between weekends and weekdays was less pronounced than was the case with white water boaters.

The daily pattern of angling use was not particularly predictable. During periods of cool weather, the majority of the fishing pressure was concentrated during the warmest part of the day. During periods of hot weather, more anglers fished during morning and evening periods as would typically be expected. However, owing to the relatively cool climate of the area, and the origin of many anglers, i.e. Texas, etc., many out-of-state anglers apparently preferred to fish during the warmest part of the day even during periods of hot weather. In addition, since many anglers were on vacation and were therefore less inclined to rise early, there was considerably less morning fishing in evidence than might have otherwise been expected. Consequently, much of the fishing use occurred during the same time period as did the peak periods of commercial boating use.

The quasi-population model developed by Harpman allows the fish population to be predicted under alternative flow management regimes. That is, it accounts for the differential effects of stream flow during different seasons. This approach is far more sophisticated than one which simply assumes fish production to be directly related to total annual stream flow. The predicted population effects of the flow release pattern associated with the Collegiate Range Project were compared with the predicted population for the current reservoir operation regime. Changes in angler catch were imputed for these scenarios. The changes in catch were valued using estimates of willingness to pay obtained from anglers fishing at the site. Total angling effort was held constant. For both of the flow scenarios examined the difference in economic use value was limited. The relatively small changes in value predicted were shaped by the small changes in catch predicted and the high number of fish caught under current conditions.

Description of White Water Boating Resource

Commercial rafting on the Taylor and Gunnison Rivers is regulated by the U.S. Forest Service and the Bureau of Land Management under the auspices of their Guide and Outfitter Program. The three commercial rafting companies who are current permit holders are required to submit use reports at the end of each season to these agencies. These records are a rich source of information on white water boating use in the basin.

During this study, the daily records from the 1988 rafting season and the season totals from the 1989 rafting season were obtained from the U.S. Forest

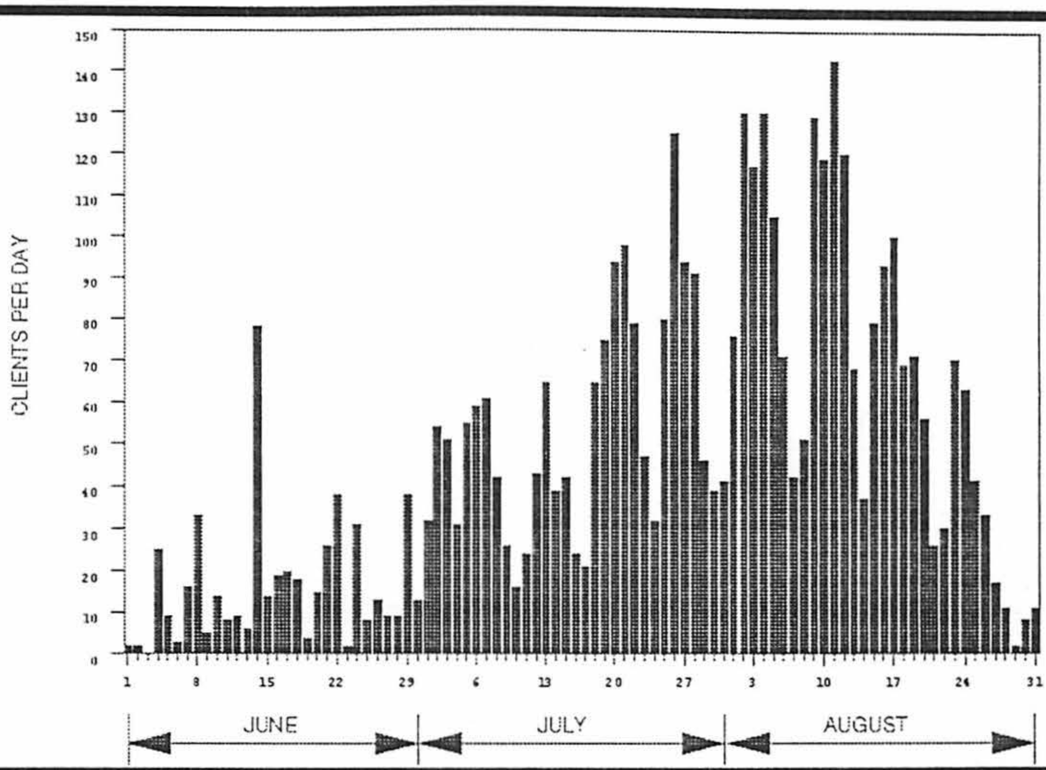

Figure 4.2 Pattern of Commercial White Water Boating Use on the Taylor River During the 1988 Boating Season.

Service, the B.L.M., and the rafting companies themselves. In 1988, commercial companies carried 4,442 clients on the Taylor River and 3,869 clients on the Gunnison River. In 1989, commercial companies carried 5,615 clients on the Taylor River and 3,207 clients on the Gunnison River. Other rafting companies have applied for permits to carry clients on these rivers but these permits have been denied pending analysis of current use and management objectives. Figure 4.2 illustrates the daily commercial boating use on the Taylor River during the 1988 season (1 June - 31 August). As illustrated in this figure, commercial boating use, which makes up approximately 88.5% of the total use on the Taylor and 95% of the use on the Gunnison, is relatively low in June, rises in July, peaks in August and falls off sharply in September. This pattern is predominantly demand driven and closely approximates the times when most Americans take their annual summer vacations. It should be noted that this pattern does not mirror the runoff pattern in this area since peak flows in the Upper Gunnison Basin usually occur in June. The pattern of use by private boaters and area residents is probably more closely related to the flow pattern than is illustrated by this figure.

Also as shown in this figure, a pronounced weekly commercial use pattern is apparent. The heaviest commercial use occurs Tuesday through Saturday. There is much less commercial use, on the average, on Sunday and Monday. The fact that this area is a destination resort is undoubtedly responsible for this pattern. Vacationers arrive on the weekend, recreate during the week, and travel back home on the weekend. This pattern is undoubtedly different for residents and private boaters, who, it might be surmised, recreate primarily on the weekends.

Daily patterns of use are fairly predictable. Since the water is quite cold, and boaters expect to get wet, most commercial boating use occurs during the warmest part of the day.

Site Value for White Water Boating--method Employed

In contrast with anglers, white water boaters are directly dependent on flows for their activity. Thus, the demand and value of stream flows for white water boating was estimated directly through the use of the dichotomous choice contingent valuation method which is described more fully in Appendix 3.

Results

During the summer of 1989, approximately 339 white water boaters in the study area were contacted by survey enumerators and the purpose of the survey was briefly explained to them. At the time they were contacted on-site, boaters were asked only if they would agree to participate in the survey. Over 99.5% of the individuals who were contacted agreed to participate. Their names, addresses, and telephone numbers were recorded by the enumerators.

Following the methodology of Dillman (1978), the surveys were first mailed to respondents in October 1989. A reminder postcard was sent in November 1989. Two weeks later, another survey was sent to individuals who had failed to respond. A final reminder postcard was dispatched in early December of 1989. All survey data was then coded and entered into the database in January 1990. Table 4.1 shows the number of returned surveys received by activity and survey type.

Table 4.1

RETURNS BY ACTIVITY

ACTIVITY	NUMBER MAILED	Not Delivered	Adjusted Sample	Number Returned	Return Rate
Fishing	287	5	282	237	84%
Boating	339	3	336	249	74%

As shown in Table 4.1, the overall return rate, adjusted for undeliverable surveys, was 78.6%. The fish population survey had the highest rate of return (84.0%) while the return rate for the white water boating survey was somewhat lower. These return rates are very high. This result may reveal the importance of this area to resource users. In part, the high rate of return may also reflect the strength of the methodology employed.

Appendix 3 explains how willingness to pay for flow at different levels of flow yields were estimated. The results of these estimates for the Taylor River are summarized in Table 4-2.

The mean flow on the Taylor River[4] during the boating season (1 June to 31 August) for the period 1952-1988 was approximately 600 cubic feet per second. A 100 cfs increase in flow (from 600 to 700) would be valued at $18.70 per boater per year. An increase of 100 cfs over the boating season is equivalent to 17,851.24 acre feet of water[5]. Multiplying the number of boaters[6] times $18.70 per boater and dividing this by the number of acre feet required yields an estimated value of $6.65/acre foot for an average year. During the 1989 boating season, the average flow was 337.37 cfs. Rounding this figure to 300 cfs, a 100 cfs increase in flow (from 300 to 400) would be valued at $74.42 per boater per year. Multiplying the number of

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4Much of the whitewater boating on the Taylor River takes place below the Taylor Park Reservoir but above the gauging station at Almont. Several ungauged streams feed this reach making it difficult to ascertain the flow rate at various points. For this reason, the flows from the Almont gauging station are used in this analysis.

5One cubic foot per second of flow, flowing for a 24 hour period is 86,400 cubic feet of water. Dividing this by the number of cubic feet in an acre foot (43,560) yields a conversion factor of 1.983471 acre feet/cfs-day. To calculate the amount of water required to supply 100 cfs flowing for 90 days, multiply 100 cfs times 90 times this conversion factor. The result is 17,851.24 acre feet.

6The number of commercial rafters carried during the 1989 rafting season inflated in proportion to the number of private boaters found during the survey.

boaters times $74.42 per boater and dividing this by the number of acre feet required yields an estimated value of $26.53/acre foot for the 1989 boating season.

TABLE 4-2		
INDIVIDUAL WILLINGNESS TO PAY FOR FLOWS IN THE TAYLOR RIVER BY WHITE WATER BOATERS		
Flow	Expected	Incremental
(cfs)	Value	Value
100	96.63	NA
200	257.32	160.67
300	376.82	119.50
400	451.24	74.42
500	496.71	45.46
600	525.28	28.58
700	543.98	18.70
800	556.71	12.73
900	565.69	8.98
1000	572.23	6.53
1100	577.11	4.88
1200	580.84	3.73
1300	583.75	2.91
1400	586.06	2.31
1500	587.92	1.86
1600	589.44	1.52
1700	590.70	1.26
1800	591.75	1.05

These estimated values are relatively high. There may be several reasons for this. First, the channel of Taylor River is narrow and the mean flow is relatively low. A 100 cfs change in flow represents a relatively large change which is likely to be perceptible to many boaters. Second, the boating experience on the Taylor River is a class II and class III white water trip. As such, it is considerably more exciting and perhaps more valuable, than a trip on the Gunnison River. Finally, the Taylor river is much more heavily used by white water boaters than is the Gunnison River. Table 4.3 shows the estimates of Gunnison River boaters' willingness to pay for stream flow. The mean flow on the Gunnison River during the boating season (1 June to 31 August) for the period 1952-1988 was approximately 1300 cubic feet per second. A 100 cfs increase (approximately 7.7%) in flow (from 1300 to 1400) would be valued at $1.64 per boater per year. An increase of 100 cfs over the boating season is equivalent to 18,000 acre feet of water. Multiplying the estimated incremental value of $1.64 per boater times the number of boaters and dividing the result by the number of acre feet required yields a value of $0.31/acre foot. During the 1989 boating season, flows averaged 776 cfs. Rounding this figure to 700 cfs, a 100 cfs increase in flow (from 700 to 800) would be valued at $2.41 per boater per year. Multiplying the number of boaters times $2.41 per boater and dividing this by the number of acre feet required yields an estimated value of $0.45/acre foot for the 1989 boating season.

The estimated value of water to boaters on the Gunnison River is lower than that for boaters on the Taylor River. There are a number of possible reasons for this. First, the channel of the Gunnison River is relatively broad and at Almont a 100 cfs change in flow represents a rise in the surface elevation of the river of only about 0.5 inches. It is doubtful that this change is large enough to be perceptible to many boaters. Second, the boating experience on the Gunnison River is predominantly a float trip rather than a white water trip.

Table 4.3		
INDIVIDUAL WILLINGNESS TO PAY FOR FLOWS IN THE GUNNISON RIVER BY WHITE WATER BOATERS		
Flow (cfs)	Expected Value	Increment in Value
100	21.56	NA
200	28.36	6.79
300	33.23	4.87
400	37.16	3.93
500	40.50	3.34
600	43.44	2.94
700	46.08	2.64
800	48.49	2.41
900	50.71	2.22
1000	52.77	2.06
1100	54.70	1.93
1200	56.52	1.82
1300	58.25	1.72
1400	59.89	1.64
1500	61.45	1.56
1600	62.95	1.50
1700	64.38	1.44
1800	65.76	1.38
1900	67.09	1.33
2000	68.38	1.28

As such, a trip on the Gunnison River is simply not as exciting as a trip on the Taylor River. Because of this, boaters may not value it as highly. Third, many of the commercial rafters on the Gunnison are older, are on multi-activity trips, and are first time rafters. For this reason they may not value a boating trip as highly as more experienced individuals on a single purpose trip. Finally, and perhaps most importantly, there are substantially fewer boaters on the Gunnison River.

Costs to Recreational Users

If the flows from Taylor Park Reservoir are reduced by 60,000 feet per year, then it is safe to assume that most of the reduction in flow will come during the summer months. Therefore computations of costs will assume that there is little effect on fishermen, since winter flows are the critical flows for fish population.

White Water Users will, however feel a significant effect. If 60,000 acre feet are taken from the flow on the Taylor, then it reasonable to assume that the average flow over the boating season will be reduced by at least 300 cfs. Given that the average flow on the Taylor is 600 cfs, we can calculate the value lost per boater year to be $148.42. Converting this to value per acre foot withdrawn gives $15.87.

In a similar way we calculate the per boater year loss on the Gunnison as $5.47 per boater year and $.31 per acre foot. Total losses to boaters is then $16.18 per acre foot.

The magnitude of loss per boater can reasonably be predicated on the average number of trips per boater being less than 3. Consequently, the decrease in value is conservatively over $40 per trip. This is enough to drastically reduce the number of boaters and quite plausibly the loss of the on the Taylor River. Loss of this industry would reduce expenditures by the 4442 clients served in 1989. If each client paid $30 per trip, the total reduction is over $100,000.

Active User CV's vs Ideal CV Criteria

Attempts were made to assure that the frequency of sampling coincided with the frequency of use during each day of the week and each week of the season. Each respondent was contacted personally and the study briefly explained. Virtually all respondents agreed to have a questionnaire sent to them. When questionnaires were sent by mail, total responses were 249 for boaters and 237 for anglers, or 74% and 84% returns respectively.

Valuation questions were asked using a referendum format--dichotomous choice. In each questionnaire, the payment was a given amount, stated as the 'fair share' of each statewide participant (boater or fisherman) in order to increment their experience (by flow or by catch) by a specified amount above what they experienced. After this question, each respondent was asked what the maximum amount they would pay was. If that amount was zero, they were asked to explain why.

When compared to the Arrow et al criteria, this format has: careful pretesting, representative samples, high returns, referendum format, yes/no follow up, conservative design, and a consistency check. It does not use an interview, a no-answer option, or an explicit payment vehicle. The decision not to use a payment vehicle was used advisedly to avoid protest votes against license fees or taxes.

5. PRESERVATION VALUE

This section reports results of a state-wide mail survey. A professional marketing research firm--National Family Opinion Research Inc.(NFO)--was retained. NFO maintains a national panel of households that have agreed to participate in its surveys. Its services are regularly used by Fortune 500 firms for market research. When presenting the results before audiences of more than about 30 people, we regularly find that some of the audience has at one time been an NFO panel member.

Representative Samples

NFO's Colorado panel had over 6000 members at the time of the survey. NFO is able to draw samples from this pool which are demographically representative of the state in terms of geography, income, age, and household size.

The contract with NFO specified that two questionnaires be sent to 1400 families--700 NFO households for each questionnaire. For each questionnaire, 630 households represented a random sample of Coloradans while 70 more were sent to NFO households in six counties with populations nearest the proposed project sites.

Questionnaire Design

User vs Non-Use Values

No attempt was made to identify direct or active users of the resource. An obvious reason to omit any question from a questionnaire is to keep it short and simple. Yet Arrow et al list this question as an important criterion for the ideal CV analysis. It is argued that the nature of our study made this question irrelevant.

Preservation value of environmental amenities has strong common sense appeal. Indeed, it would be difficult to otherwise explain willingness of society to dedicate large tracts of land to national parks and national forests at some expense to taxpayers.

Economists interested in these questions pondered the meaning of 'preservation value,' for some years, and identified a number of possible motives. These include option value, bequest value, and existence value.

Option value suggests the notion that citizens are willing to pay for something to exist in order that they have the option to someday visit, experience, or in some sense directly use it, much in the same way that options are sold which allow people first right to purchase something in the future.

Existence value suggest that people derive satisfaction just from knowing that something like an endangered species exists even if they are certain they will never directly experience it.

Bequest value extends the other values to one's heirs, and if altruism is permissible, to future generations in general. Recently economists have made a functional distinction between active users and passive users of resources, e.g. Arrow, et al. It is clear that option, existence and bequest values belong to the later category. It is not always clear whether viewing is active or passive, but that distinction is not very important here. For a more detailed discussion of non use values, please see Appendix 1 where Harpman et al discuss the current disputes over the use of passive use values.

One need not be an economist or lawyer to understand these basic ideas. Nor does one need to be an economist to suspect that passive use values may differ greatly between different citizens. Reflecting a step further, it is likely that anyone who is a direct user of these resources -- an angler or a whitewater boater in the present case -- has their own preservation values apart from the direct values they receive. For example, active users' option values will be higher than the average since they are more likely to want to use the resource in the future. Moreover, their appreciation of the resource is higher than the average so that their existence and bequest values are also likely to be higher.

It is important to keep these values separate in order to avoid double counting. Therefore, it might seem important to keep the two groups separate, particularly to exclude active users from the preservation survey. We reason, to the contrary, that our user questionnaires asked only about the quality of the use at the time of contact, and willingness to pay for a measurable increment in the quality of that experience. Therefore preservation value was not a part of the users' willingness to pay.

It follows therefore, that our random sample of Colorado families should include some who are familiar with the resource as well as those who have never experienced it. Additionally, the preservation survey applies to sites distinct from the rivers being used by our active use respondents. As a consequence, our preservation survey makes no attempt to distinguish active users and passive users.

Description of Project Sites

Early versions of the questionnaire included both sites and explained in detail what potential environmental impacts of each project were. Pretesting suggested that this was an information overload, even for highly educated respondents. An industrial organization psychologist, Dr. Jack Hautaloma, was hired as a consultant and he suggested that it is unrealistic to expect respondents to a mail survey to read more than one page.

At Dr. Hautaloma's suggestion, we contacted NFO in order to gain their professional services in questionnaire design in addition to the advantages of a representative sample and a high return rate.

Each questionnaire (See Appendix 4) include photo(s) of the proposed reservoir site(s), with a facing page that contained

1. a brief description of the site and the project
2. a section entitled POSSIBLE BENEFITS,
3. a section entitled POSSIBLE ENVIRONMENTAL EFFECTS

These were concise, but arguably held as much information as an average voter might be expected to retain if the projects were subject to referendum. A few respondents commented to the effect that they did not have enough information to vote. Our judgement was that there is considerable awareness of the general issue surrounding new water projects due to the (at that time) on-going debate over the proposed Two Forks reservoir. The tradeoff between more detail and high response rates was decided in favor of high response rates.

Questionnaire format

The question page was identical for each questionnaire. First respondents were asked to vote on the project based on the description they had just read. There was not a no-opinion option, but a number of respondents did refuse to vote.

If the respondent was in favor of the project, they were asked to skip the valuation question and skip to the last question which asked for age and gender of the respondent.

If the respondent was opposed to the project, they faced a valuation exercise. The first part of the exercise was to read a paragraph explaining a vehicle for payment of preserving the project area. It posited that preservation would result in higher household water bills, and that the respondent was asked to indicate a range of yearly costs by marking three amounts:

A. An amount which is "reasonable"

B. An amount which "begins to be too expensive"

C. An amount which would "become too high"

The respondent had choices of 8 ranges, from less than or equal to $1/year to "$200.01 to $500"/yr, plus a blank to specify another amount.

This format differs from formats used in other surveys--it is not entirely 'open ended,' asking for a maximum amount. Rather it asks for what seems 'reasonable,' vs what might be consider an 'indifferent' cost, vs what is out of the question. Respondents seemed to find this easy to understand judging from the near total lack of inconsistent answers.

Additionally, this format gains much more information from each respondent that would either the maximum amount, or the dichotomous choice questions. Moreover, the respondent is drawn to think in terms of an annual increment to their expenses, and to consider what is 'reasonable,' vs what begins to be expensive vs what just crosses the line to be out of the question. Given the nature of the projects, a water bill is a very realistic and market like vehicle.

Based on the format of the questionnaire, we used responses above $200/yr as inherently unreasonable and to discard them as strategic behavior votes. Given the constraints of a mail out preservation survey, this design is arguably superior to either open ended or dichotomous choice designs. However, we know of no experimental results reflecting on this argument.

Finally, an added advantage of using NFO's services is that they always pretest each questionnaire twice: once on their staff and once on a small sample of their panel. Thus, while the questionnaire did not meet all of the Arrow et al criteria, it strongly met criteria of probablistic sample design, high response rates, and rigorous pretesting.

Results

Response Rates and Referenda

The response rate for the Collegiate Range project was 406 out of 627--about 65%. Of these, 294 were opposed to the project, 102 favored the project, and 10 abstained. The response rate was somewhat higher to the Union Park questionnaire, 441 out of 628--over 70%. Of these, 249 voted against the project, 181 voted in favor of the project, and 11 abstained.

Over sample return rates were 70% for Union Park and 75% for the Collegiate Range Project. Of 51 Union Park returns, 39 opposed the project and 12 voted in its favor while 52 of 56 Collegiate Range respondents voted against that project, 2 in its favor and 2 abstained.

Valuation Results

Some respondents who were in favor of a project also marked the valuation section. We interpreted this to mean that, if the price were low enough, they too would vote against the project and opt to pay slightly higher water bills.

For the valuation portion, responses were subjected to two consistency tests. First if the respondent checked that they would not be willing to pay anything for preservation and also checked that they found some amount 'reasonable,' the response was considered inconsistent and was discarded. Second, if the respondent gave a higher amount for reasonable than for the other two categories, or a higher amount for begins to be expensive than for just too expensive, the response was discarded for valuation purposes.

Finally, in the most conservative interpretation, responses were screened for strategic voting by discarding all of those that gave amounts above $200/yr. On this basis, there were 406 usable responses for Union Park and 378 usable responses for Collegiate Range.

Using the usual economists' definition of indifference, the proper answer to use for judging 'willingness to pay' is "just begins to be expensive," since this can reasonably be interpreted as a point of indifference. Using this criterion, the average willingness to pay for preserving the Collegiate Range sites was $23.91 per household. For Union Park the figure was $21.88.

Representativeness of Data

High response rates and an initial pool balanced to the census suggests that our sample is close to representative of Colorado households, at least as CV surveys usually go. An advantage of using NFO's panel data is that we have demographics for the non-respondents as well as the respondents. Households that responded were not significantly different from the population in terms of county of residence, age of female head of household, or income.

Figure 5.1 and figure 5.2 show a comparison of population income distribution to the income distribution of respondents to the Union Park and Collegiate Range questionnaires, respectively. Since the expected number of respondents (based of the population frequencies) in each income category was well above 5, a Chi square with df=10 could be used to test whether the income frequency of respondents was significantly different from the population income frequency. In the case of Union Park, the corresponding P value is greater than .81 and in the case of the Collegiate Range, the P value is greater than .92.

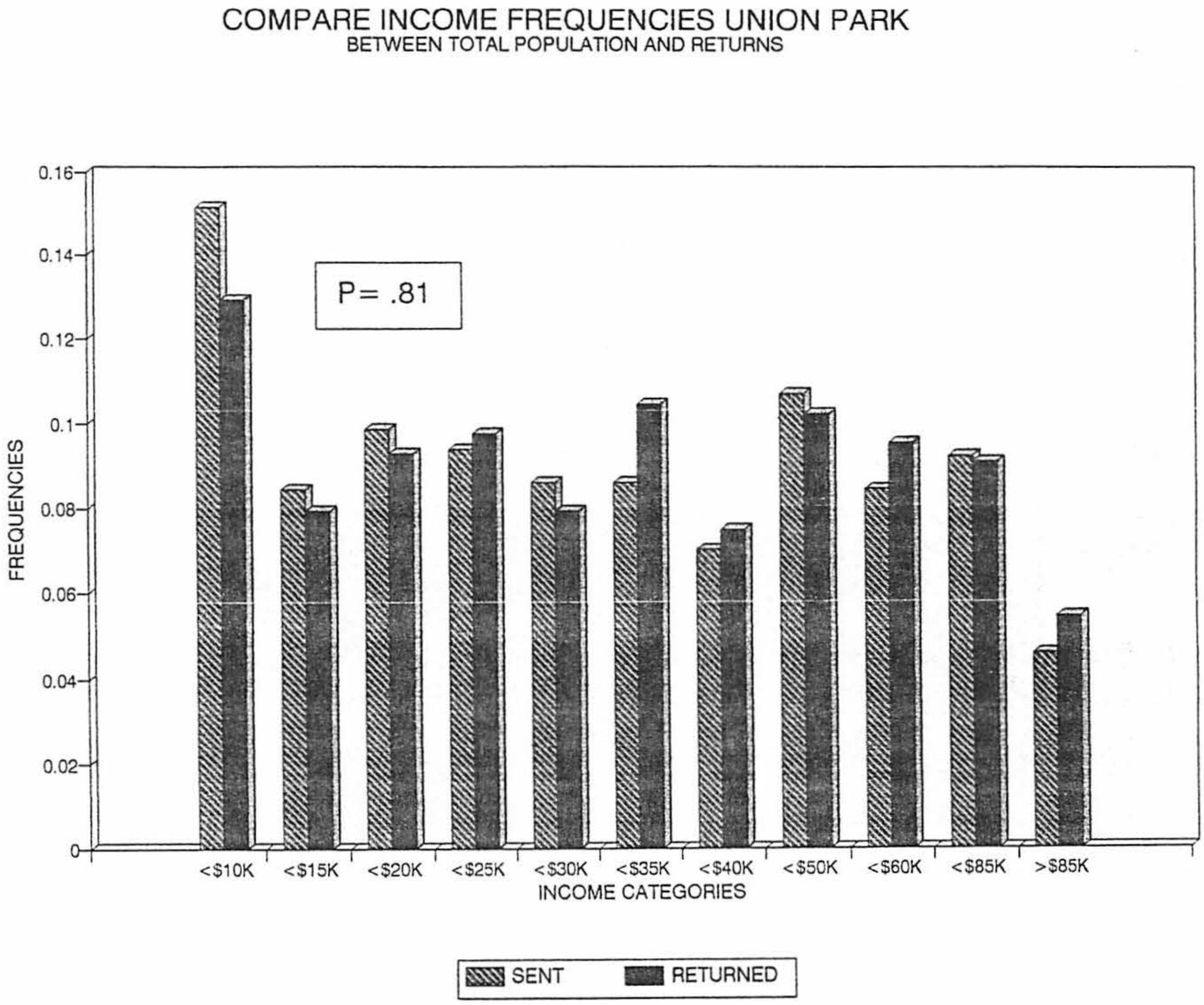

Figure 5.1 Union Park Returns vs Whole Sample

Similar comparisons were made for age and education. Using the conventional multivariate Chi Square tests, the P values were over .7 except for age which were .2 for Collegiate Range and .28 for Union Park. While the represenativeness with respect to education and income are encouraging, the results with respect to age are some what troublesome.

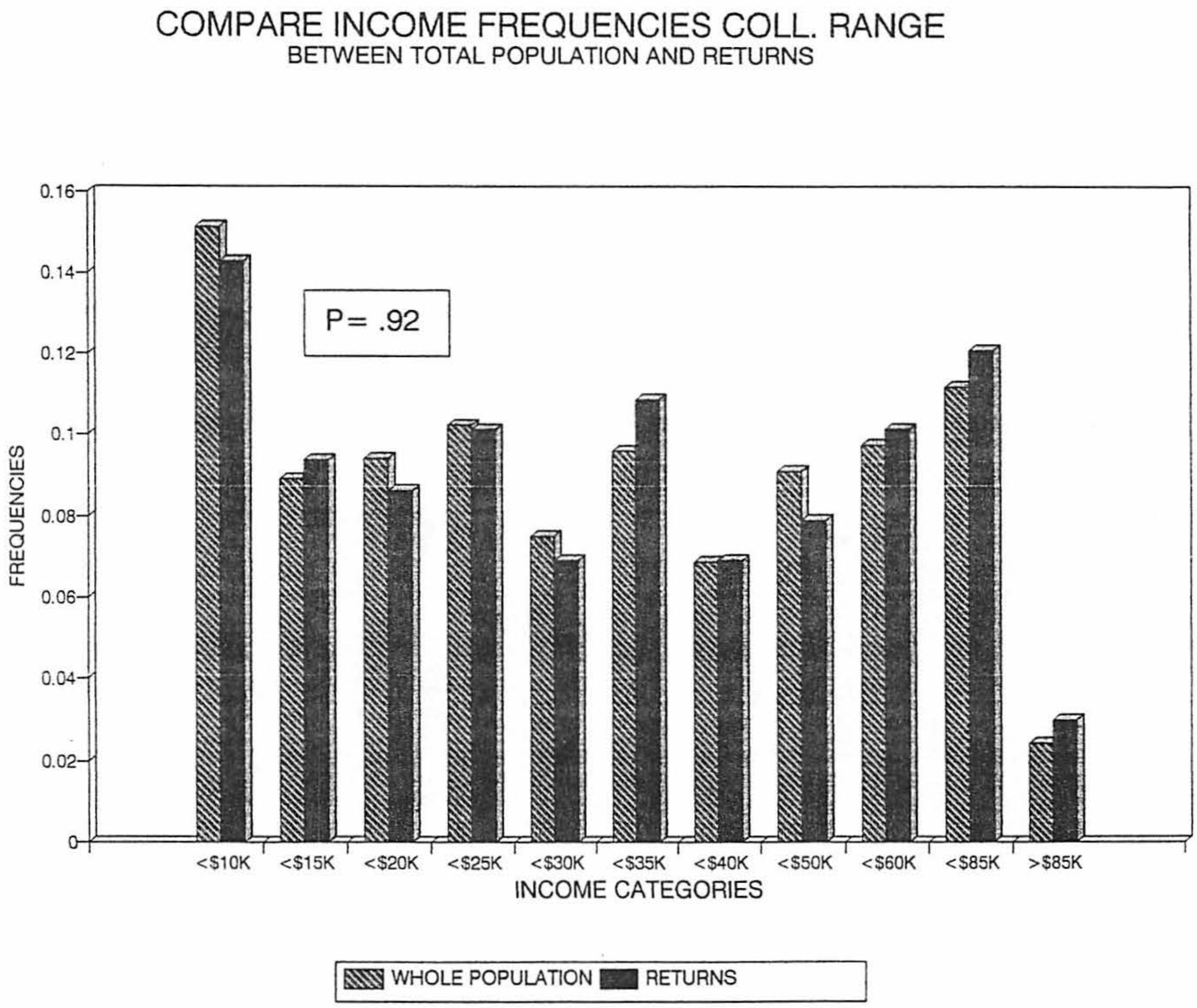

Figure 5.2 Collegiate Range Returns vs Whole Sample

Of course, multiple regression techniques or logit type analogues for dichotomous dependant variables should handle the problem of adjusting for differential response rates, the task of deriving an estimator which at once exploits the multiple responses per observation and multiple explanatory variables is non-trivial. In the meantime, we can take comfort in knowing that the respondents constitute a representative sample across most demographic variables. The usual state of affairs is that the demographics are not known for non-respondents.

Bootstrapping Mean Willingness to Pay

A simple and powerful method of estimating means and standard errors of our sample WTP is the bootstrap method (Efron,1982). This entails repeatedly drawing samples the same size as the original from the original sample, with replacement. Since the number of observations is large, the number of resamples were 200.

Using this method, the mean WTP for the Union Park sample was $21.75 per family and the mean WTP for the Collegiate Range was $23.78. Standard deviations for these two estimators were, respectively, $2.07 and $2.11. By assuming the bootstrap estimators to be normally distributed (a strong assumption when drawn under the bootstrap rules), we can set a lower 1% confidence level of $16.99 for Union Park and $18.13 for Collegiate Range.

An alternative method of computing a conservative estimator of WTP is to use the average for the 'reasonable' responses. This gives $21.28 for the Collegiate Range questionnaire and $18.51 for the Union Park questionnaire.

A Hybrid Approach

The economist's reasoning behind using aggregate willingness to pay as a criterion for measuring acceptability of a project has to do with a 'conceptual' reimbursement of losers by gainers. This ignores the political reality that any referendum needs a majority of 'gainers' if a tax is to actually be voted in. Therefore, we tested each project for the maximum increment which could be agreed to by a majority of the state's voters. In the case of the Collegiate Range Project, this amount was $5 per family per year and in the case of the Union Park Project it was $1 per family per year. In both cases, a majority of respondents from the Denver Metropolitan counties (those whose water bills are most likely to be raised) also would agree to pay these amounts.

Table 5.1 gives a summary of various estimates of WTP and the implied cost per acre foot per year to be added to the cost of the two projects. Figures in parentheses are standard errors of the means as estimated using the bootstrap technique (T=100).

TABLE 5.1 FIVE ESTIMATORS FOR WTP FOR PRESERVATION		
	Union Park	Collegiate Range
(1) "Just Begins.." Consistent Respondents	$40.92 or $875/af** (8.89)	$30.70 or $562/af*** (4.71)
(2) "Just Begins.." Consistent and Not Excessive Respondents	$21.75 or $465/af (2.07)	$23.78 or $436/af (2.11)
(3) One Percent Lower Bound of (2)	$16.99 or $363/af	$18.13 or $332/af
(4) "Reasonable.." Consistent and Not Excessive Respondents	$18.51 or $396/af (2.16)	$21.28 or $390/af (1.88)
(5) Politically Feasible	$1.00 or $21/af	$5.00 or $92/af

**Based on 1,282,489 household in Colorado, US Census of Population and Housing, 1990 and 60,000 af/yr annual yield.
***Based on census and 70,000 af/yr annual yield.

Discussion

Note that the first set of estimators are those which might normally be used in contingent valuation studies. By deleting the highest responses in (2), we have arguably deleted strategic responses. The result is lower, but still substantial willingness to pay for preservation. An additional advantage of deleting these responses is the much smaller standard error terms (in parentheses).

Note that for the four more conservative estimators, there is a consistent difference between willingness to pay for preservation of the Collegiate Range sites as opposed to the Union Park site. While the differences between estimators (2) and (3) and (4) are not large, the difference for estimator (5) is, and the voting results differed substantially in the same direction.

The sample demographics were very close for both questionnaires, as were the sample sizes. The questionnaires were similar as well, and the sites were in the same area. The results of this study seem to suggest that CV studies such as this one <u>can</u> make subtle distinctions between projects.

Its interesting to speculate as to why the Collegiate Range Project drew a stronger willingness to pay. The Collegiate Range photographs are not as dramatic as the Union Park photograph, so that probably does not explain the difference. It seems plausible that the fish hatchery/salmon run makes the difference. In which case, there seems to be evidence that respondents really do read the details of the questionnaire--at least respondents who have agreed to participate in NFO's panel.

6. CONCLUSION

The parts of this study are drawn together as evidence of the uncompensated values of water diverted from the upper Gunnison River. Under the usual definition, parts relevant to Colorado are those which directly affect Coloradans. In this view, downstream values which accrue to lower basin states are irrelevant.

Yet the willingness of lower basin states to pay for Colorado River water should not be dismissed out of hand. If it becomes possible for Colorado to 'rent' water to other states, there is clearly the possibility to capitalize the willingness of lower basin states to pay for water in very dry years. In the meantime, the values of instream flows could be preserved.

Uncompensated Costs of Proposed Projects

Table 6.1 displays the uncompensated values of water diverted from the upper Gunnison to Colorado's Front Range. Note that the values which accrue in the lower basin are more than one half of the total. Even if the out of state parts are ignored, the uncompensated costs would be in excess of $400X 60,000 = $24,000,000 per year. If this were capitalized at a 7% discount rate, the total cost would be over $300,000,000. If the cost to lower basin states were considered, then the total would be in excess of $600,000,000. Since some of this part may eventually be realizable, and hence of real economic relevance to Coloradans.

Annual uncompensated costs for the Collegiate Range Project would then be between $48,420,000 and $54,660,000. If these were capitalized into a present value, then the Collegiate Range Project would have uncompensated costs between $484,000,000 (low estimate of annual costs at a 10% discount rate) and $1,093,200,000 (high estimate of annual costs at a 5% discount rate). Corresponding figures for the Union Park project are $586,600,000 and $1,316,000,000.

TABLE 6.1 Summary of Estimated Uncompensated Costs Associated with Exporting Water from the Taylor River	
MARKET VALUE	
Hydro Electric Power	$67.17/acre ft
Calif Municipal Demand	$390.00/acre ft
TOTAL MARKET VALUE	$457.17/acre ft
NON-MARKET VALUE	
White water boating	$16.18/acre ft
Angling--Taylor River	$1.43*/acre ft
Preservation value	$332 to $436/ acre ft (Coll. Range) $363 to $465/ acre ft (Union Park)
TOTAL NON-MARKET VALUE:	$350 to $454/ acre ft (Coll. Range) $381 to $483/ acre ft (Union Park)
TOTAL UNCOMPENSATED VALUE:	$838 to $940/acre ft (UNION PARK) $807 to $911/acre ft (COLL. RANGE)

The size of these figures is impressive, and should not be ignored. In each case, the lower figure really is conservative--both in assumptions about preservation value and the discount rate applied. If each is further reduced to take out the lower basin costs, there the uncompensated costs must still include Colorado's share of hydropower foregone and the resulting costs will still top $250,000,000 for the Collegiate Range Project and $350,000,000 for the Union Park Project.

Methodological Significance of the Study

The significance of this study does not stop with the estimation of uncompensated costs of water diversion. A number of innovative methods were used, and several show promise to improve contingent valuation studies. The more important of these include:

1. New methods for eliciting willingness to pay, using simple ordered responses from each individual. These are methods already in use in business marketing, but new to economics.

2. Derivation of efficient statistical estimators for use with multiple, ordered responses.

3. Use of commercial market panels has promise for use in CV analysis because of the high response rates and abundance of cheaply available demographic data. Other researchers have begun to use these panels--e.g. R. Walsh and J. McKean are currently conducting a study using NFO.

4. The finding that the median willingness to pay to preserve areas affected by the project differed between the Union Park and the Collegiate Projects suggests that many respondents do distinguish between 'good causes,' since the two projects are superficially about the same.

5. The technique used first with the preservation study has been successfully used to study consumer willingness to pay for organic fresh produce.

6. The fishery study has set a new standard for rigorous application of biological models in the context of a valuation study. It has dispelled simplistic notions that economic yields of fisheries are direct functions of total instream flows. In particular, the importance of timing of flows is now better understood by fishery economists.

Social Significance of the Study

The original motivation for the study was the need for quantified evidence regarding the magnitude of values attributable to water running in Colorado's mountain streams. The evidence contained in this report and future publications will help to inform the public discussions regarding the economic value of instream flows. To this end, High Country Citizens' Alliance of Crested Butte will coauthor and publish a pamphlet based on the results of this Ford sponsored study.

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APPENDIX 1.

NONUSE ECONOMIC VALUE: EMERGING POLICY ANALYSIS TOOL

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NONUSE ECONOMIC VALUE: EMERGING POLICY ANALYSIS TOOL

ABSTRACT: Nonusers, or individuals who never visit or otherwise use a natural resource may nonetheless be affected by changes in its status or quality. Monetary expression of their preferences for these resources is known as nonuse or passive-use economic value. Empirical estimates indicate that nonuse value may be substantial for some resources. Inclusion of nonuse value in economic efficiency analyses may alter the outcome of these analyses in some cases. So far, applications have remained largely in the research realm. However, changes in the legal and institutional framework and recent policy pronouncements make it probable that nonuse value will play an important role in natural resource decision making in the future. We briefly discuss the concept of nonuse economic value and its relevance in water resource decision making. The current institutional framework and the applicability and integration of nonuse value within the National Environmental Policy Act (NEPA) process are explored. Details of an ongoing application for the Glen Canyon Environmental Studies Program are described.

KEYWORDS: passive-use value, nonmarket goods, contingent valuation methodology (CVM), National Environmental Policy Act (NEPA), environmental impact statement (EIS), Glen Canyon Dam, Grand Canyon National Park.

NONUSE ECONOMIC VALUE: EMERGING POLICY ANALYSIS TOOL

INTRODUCTION

Broadly interpreted, the concept of nonuse value may be traced back at least as far as the U.S. conservation movement of the early 1900's. Beginning with Weisbrod (1964) and Krutilla (1967), economists have more narrowly defined the concept and have employed it within the context of economic theory. Economists acknowledge that nonusers, or individuals who may never visit or use a natural resource, can be affected by changes in its status. Expression of their preferences for the state of these resources is called nonuse value. Economists also use the terms passive-use value and intrinsic value to describe these preferences.

Until quite recently, quantification of nonuse economic value has remained largely an academic exercise. Neither the concept of nonuse value nor estimates of its magnitude have played a substantive role in decisions regarding resource allocation. As a result of several proposed regulations and pronouncements (U.S. Department of the Interior 1991, 1994; U.S. Department of Commerce 1990, 1991, 1992a, 1993, 1994), nonuse value is likely to be an important component of the natural resource decision making process in the future. We briefly discuss the concept and its implications for water resource decisions, describe the current institutional framework, and detail an ongoing application for the Glen Canyon Environmental Studies Program.

NONUSE VALUE

Early writings on nonuse value focussed on two topics: existence value and bequest value. Existence value is the benefit generated today by knowing that a resource exists even if no onsite use is anticipated. Bequest value is the value individuals gain from the preservation of the resource for use by their heirs. Although the distinction between existence and bequest value still persists in parts of the literature (e.g., Loomis 1989), the term nonuse value is used here in a more general manner that encompasses both of these constructs.

A third concept often associated with nonuse value is option value. Although this topic has generated considerable debate in the literature, it now is generally acknowledged that option value is not a component of nonuse value. In the modern literature the term option value is used to describe the difference between two alternative measures of economic welfare under conditions of uncertainty (Ready 1993).

Nonuse value: concept and origin

The concept of nonuse economic value has its origins in both the classic literature and in more recent works. In his seminal article on nonuse value, Krutilla (1967:781) made the often quoted observation that, "There are many persons who obtain satisfaction from the mere knowledge that part of the wilderness of North America remains, even though they would be appalled by the prospect of being exposed to it."

In a later work, Bishop and Heberlein (1984) noted that nonuse value could be motivated by sympathy for and empathy with people and animals, environmental linkages, feelings of environmental responsibility, and bequest goals. They pointed out (p. 10): "Even if one does not plan to personally enjoy a resource or do so vicariously through friends and relatives, he or she may still feel sympathy for people adversely affected by environmental deterioration and want to help them. Particularly for living creatures, sympathy may extend beyond humans."

The discourse on the factors that underlie nonuse value is extensive (Boyle and Bishop 1987; Madariaga and McConnell 1987). In lieu of a lengthy discussion we offer the following summary: a frequently discussed basis for nonuse value is the desire to maintain the functioning of specific ecosystems. The preservation of the natural ecosystem to allow for future use is also regularly cited. Still other authors cite a feeling of environmental responsibility or altruism toward plants and animals as a possible motivation for nonuse value.

Nonmarket value, total value, use, and nonuse value

Values for goods traded in the market are called use values and are the traditional measure of value for changes in water resource management. Familiar water resource examples are irrigation benefits and hydropower benefits. Theoretically similar measures of use values for nonmarketed goods, such as recreational use, are also routinely used to support decision making (U.S. Water Resources Council 1983). Nonuse values are a special case in which the nonmarket good is the status of the natural or physical environment.

To define these measures in a rigorous way, we presume that individual consumers use their income to purchase marketed goods, combine these marketed goods with time, human knowledge, and those nonmarketed goods that are available to them to produce a particular quality of life. Couched in these terms, it is clear that an individual's perception of his or her own well-being is determined by the interaction of preferences and the availability of market and nonmarket goods.

This can be more formally illustrated within the context of neoclassical economic theory. First, let $U(\mathbf{x},R)$ be a utility function describing individual preference as a function of the vector of goods which can be purchased in the market, **x**, and a nonmarket resource, R. Let **p** be the vector of market prices corresponding to **x**. Assume that the quality or state of the resource, R_i, is known with certainty. By making the usual assumptions about the properties of utility functions and including R as if it were a conventional good, we may define an expenditure (cost) function as shown in [1] where u^* is some reference level of utility.

$$c(\mathbf{p},R,u^*) = \min\{\mathbf{xp} \mid U(\mathbf{x},R) = u^*\} \qquad [1]$$

In [1], $c(\cdot)$ expresses the minimum cost of achieving u^*, given some resource level, R. Assume that R_1 and R_2 are two different levels of the resource such that $R_2 > R_1$ and $U(R_2) > U(R_1)$. Using this framework, further assume that there is an improvement in the resource from R_1 to R_2.

The total economic value (TV) of this increase in the level of the resource is given by:

$$TV = c(\mathbf{p}_1, R_1, u^*) - c(\mathbf{p}_2, R_2, u^*) \quad [2]$$

Where $\mathbf{p}_1$ is the initial vector of prices and $\mathbf{p}_2$ is the relevant vector of prices under the improved situation.

If $\mathbf{p}^c$ is a vector of (choke) prices which drives Hicksian demands for nonmarket use of the resource R to zero, the existence value (EV) of the change in the resource is then defined as shown in [3].

$$EV = c(\mathbf{p}^c, R_1, u^*) - c(\mathbf{p}^c, R_2, u^*) \geq 0 \quad [3]$$

Note that when the price vector is $\mathbf{p}^c$, there is no in situ use of the resource regardless of the quality or level available. As shown in [3], existence value (EV) can exist independently of resource use. From this independence springs the term "nonuse" value.

Subtracting existence value (EV) from total value (TV) yields use value (UV).

$$UV = TV - EV \quad [4]$$

When resource states, R_i, are known with certainty, it is easily demonstrated using [4] that an economic analysis that focuses only on use value will understate the true economic implications of management options affecting resources for which there is nonuse value.

Indicators of significant nonuse value

The literature emphasizes that nonuse value is most likely to be greater where the resource in question is unique and/or where adverse impacts are irreversible. Indicators of nonuse value are described in the proposed U.S. Department of Interior rules for damage assessment (U.S. Department of the Interior 1991), which state:

> "... an injury to a common natural resource with many substitutes (eg., a typical small stream), may not generate large nonuse values, particularly for those residing outside the area where the injury occurred, even if the recovery takes a long time. However, a permanent injury to a unique resource (eg., **the Grand Canyon** [emphasis added]) may generate significant nonuse values, even for those residing in areas far removed geographically from the site where the injury occurred."

To elaborate, the significance of nonuse value may depend on the irreversibility of the action; the irreplaceability of the resource; whether the resource is regionally, nationally, or internationally significant; whether threatened or endangered species or their habitats are involved; and whether use is rationed. That is not to say that nonuse value does not exist for mundane lesser known resources, only that the case for nonuse value is strongest in these instances.

Proposed management activities that result in either a long-term or an irreversible impact on a natural resource suggest a change in nonuse value. The analysis of hydropower development in Hell's Canyon by Krutilla and Fisher (1975) is a classic example. This work provides a compelling and often cited argument for including nonuse value in applicable economic analyses.

An irreplaceable resource is one for which there are few or no substitutes available. A common example of an irreplaceable resource is an archeological site. Once an archeological site has been disturbed or destroyed it cannot be replaced. Management actions that affect irreplaceable resources suggest that changes in existence and/or bequest value may result from the proposed action.

Some proposed management actions may impact resources that are widely acknowledged to be of regional, national, or international significance. An example of such a resource is Old Faithful Geyser in Yellowstone National Park. As a result of the widespread interest in this site, the population potentially impacted by any contemplated management action affecting this site is potentially quite large. Contemplated actions may generate public and political controversy that provides a fairly reliable indicator of the geographic scope of the impact. All other things being equal, the greater the scope of this impact, the more likely it is that nonuse value is a significant component of the total economic value of the site.

Management actions that affect threatened or endangered species, subspecies, or populations may be presumed to involve nonuse value. This is particularly true in the case of a well known species, such as salmon, Oncorhynchus spp., where nonuse value is likely to be large and significant (Olsen et al. 1991) but has also been demonstrated for lessor known species such as the striped shiner, Notropis chrysocephalus (Boyle and Bishop 1987).

At times, the physical use of a resource may be rationed or restricted by regulations. These measures often are implemented for safety reasons, to diminish crowding, and to prevent overuse of the resource at the effective entry price. As a consequence of rationing, the number of resource users is smaller than it would be if price were the only barrier to entry and the population of nonusers is larger. When use is rationed, the use value component of total value is reduced and the nonuse value component assumes relatively greater importance.

Estimating nonuse value

Although other techniques may emerge (Larson and Loomis 1993), the contingent valuation method (CV or CVM) is the only methodology currently available for estimating nonuse value. In its simplest terms, contingent valuation is a means of eliciting the maximum amount (in dollar terms) that an individual would be willing to pay for a resource of a specified quantity and quality.

Many recent contingent valuation studies make use of a dichotomous or binary choice questioning format. In this questioning format, a contingent or hypothetical program is described to the respondent. The respondent is then asked a single question: "If this program cost your household $X.00 per year, how would you vote for this program; YES or NO." Dichotomous choice contingent valuation is now widely applied because it closely resembles a referendum or voting situation in which the respondent is faced with the decision of whether or not to vote for a ballot initiative that has some specified cost.

Rather exhaustive descriptions of the contingent valuation methodology are found in Cummings et al. (1986) and Mitchell and Carson (1989). Carson et al. (1992) provide a very useful bibliography of contingent valuation studies and related subjects.

NONUSE VALUE AND WATER RESOURCE PLANNING DECISIONS

The role that nonuse value might play in water resource planning decisions is at least partly a function of the relative magnitudes of use and nonuse value. Fisher and Raucher (1984) provide a review of early water quality studies in which both use and nonuse value were estimated. A very useful paper by Brown (1993) reviews 31 nonuse value studies published since 1981. Of particular relevance are a subset of recent studies that have explored the nonuse value for water resources.

In one such study, Loomis (1987a, 1987b) estimated both use and nonuse value for Mono Lake in California. He reported that use value was approximately $40.00 per visit. Aggregated over 145,000 visits, use value totaled $5.8 million annually (Loomis 1987b:109). For households, estimated nonuse value was $42.71 per year. Aggregated over 9,988,060 households in California, nonuse value was approximately $422 million annually (Loomis 1987b:49).

Sanders et al. (1990) estimated the total value of preserving fifteen wild and scenic rivers in Colorado. They reported that Colorado residents expressed a use value of $19.16 and a nonuse value of $81.96 per household per year. The total (use and nonuse) value of protecting 15 Colorado rivers aggregated over the 1,185,000 households was approximately $120 million annually. The nonuse component of total value was approximately four times the recreation use value component.

Olsen et al. (1991) estimated the use and nonuse value of increasing salmon and steelhead stocks in the Columbia River Basin. In their study, 2,907 Pacific Northwest households were interviewed to determine whether they were users or nonusers of these fish stocks. Approximately 56% of the sample were classified as nonusers and 44% as resource users. Using a smaller subsample of the individuals who answered a willingness-to-pay survey, the authors report that the regional benefit of doubling the salmon stocks is over $171 million annually. Of this total, nonusers plus nonusers with some probability of future use, were willing to pay $60.255 million annually and users were willing to pay $110.943 million annually.

Whitehead and Groothuis (1992) estimated the total value of water quality improvements in North Carolina's Tar-Pamlico River. They reported that the sample mean willingness-to-pay for users was approximately $35.00 and for nonusers was $25.00. Aggregated over the 105,948 households in the basin, the total annual value of the proposed water quality improvement was approximately $1.62 million. At least 84% of this total value was ascribed to nonuse value.

The examples cited here are by no means a comprehensive list of recent studies. However, they serve to illustrate the findings of many such studies: that nonuse value is a sizable component of total economic value.

INSTITUTIONAL AND LEGAL SETTING

The Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (1983), known as the "P&G's," guide the project planning efforts of various Federal water resource agencies. The P&G's clearly recognize both market and nonmarket economic benefits. However, the P&G's were published before many nonuse value studies appeared in the literature. While the estimation techniques and underlying theoretical precursors to nonuse value are described, the P&G's contain no explicit reference to the estimation, use, or display of nonuse benefits in the water resource planning process.

Under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Clean Water Act, parties responsible for the discharge of oil and hazardous substances into the environment are liable for resulting damages to natural resources. The U.S. Department of the Interior (DOI) was assigned to promulgate rules for assessing such damages. The original rules for damage assessment, published by DOI in the Federal Register on August 1, 1986, allowed the inclusion of existence value provided that use value could not be measured.

Several aspects of the original damage assessment rules were challenged in court in State of Ohio v. Department of the Interior (880 F.2d 432 [D.C. Cir. 1989]). In a 1989 ruling on this case, the U.S. Court of Appeals for the District of Columbia Circuit further strengthened the case for including the values held by nonusers in determining the magnitude of damages resulting from oil spills and toxics. The decision states that nonuse values "may represent 'passive' use, but they nonetheless reflect utility derived by humans from a resource, and thus prima facie ought to be included in damage assessments." This same decision rejected the notion that nonuse value could be counted only if use value could not be measured.

Proposed modifications to DOI rules that would implement the Court of Appeals decision explicitly recognize that public resources damaged by oil or toxics may have "compensable values" that include nonuse values (U.S. Department of the Interior 1991, 1993). Compensable values are subdivided into two parts: use value and nonuse value. Nonuse values are defined as the difference between (total) compensable value and use value. One example of nonuse value discussed in the proposed rule is stated as, an individual's "... willing[ness] to pay to avoid the loss associated with knowing wildlife were injured, even though they will never visit the injured area."

The Oil Pollution Act of 1990 (OPA) directed the National Oceanic and Atmospheric Administration (NOAA) to develop procedures for natural resource trustees to use in the assessment of damages for injury to, destruction of, loss of, or loss of use of natural resources covered by OPA. OPA also provides for the trustees to present a claim, recover damages, and develop and implement a plan for the restoration, rehabilitation, replacement, or acquisition of the equivalent of the natural resources under their trusteeship.

In a series of Federal Register notices (Department of Commerce 1990, 1991, 1992a), NOAA requested information and comments regarding possible approaches for damage assessment and future regulatory procedures. Subsequently, NOAA extended the comment period and announced the formation of an expert panel headed by two Nobel Laureates, Dr. Robert Solow and Dr. Kenneth Arrow (Department of Commerce 1992b).

The January 15, 1993 issue of the Federal Register (Department of Commerce 1993) contained the findings of the NOAA expert panel. The panel found that, "...CV studies can produce estimates reliable enough to be the starting point of a judicial process of damage assessment, including lost passive-use values." (Department of Commerce, 1993:4610). The panel also issued a set of guidelines for conducting acceptable studies for this purpose. Subsequently, NOAA issued their proposed damage assessment rules (Department of Commerce 1994) and DOI followed shortly thereafter (Department of the Interior 1994)

These events are important for two reasons. First, the findings of the NOAA panel lend support to the use of contingent valuation methodology and to nonuse or passive-use value as a measure of impact. Second, the guidelines offered by the panel and suggested in the proposed rules will provide direction and standards against which the adequacy of contingent valuation studies may be measured in the future. As such, the findings of the panel and these proposed regulations are likely to lead to a more widespread application of nonuse value in the policy arena.

PHILOSOPHY, STRATEGY, AND OTHER ARGUMENTS

Heretofore, the concept of nonuse value was regarded by all but a small group of researchers as a theoretical curiosity, a subject to be written about by economists in specialized journals without import to the real world decision making process. As such, the concept, its potential applications, and the implications of these applications were largely ignored. Movement of this construct beyond the realm of mere theory, into empirical research, and now (potentially) into application in management decisions, has created considerable controversy.

Interestingly enough, the most vociferous objections have come from constituencies such as advocates for agricultural and hydropower development projects which have traditionally been supporters of economic efficiency based decision making. In addition, oil companies, chemical companies, and various industrial groups have made a concerted effort to block the admission of nonuse economic value in damage assessment proceedings. These objections are, in the economist's view, primarily strategic in nature. Inclusion of nonuse benefits in efficiency analyses may well call into doubt the outcome of analyses following historical approaches which- in the absence of nonuse benefits- could be expected to support the position of these constituencies. Similarly, estimates of damage to natural resources which include lost passive-use value- will be higher.

Apart from the strategically based objections described, academics, professionals, and resource managers have continued a lively dialogue on the subject of nonuse value. Philosophical objections and technically based objections are commonly voiced. While these Although these concerns are often genuine, it is difficult at times to discern the difference between them. Moreover, both philosophical and technical arguments have sometimes been advanced to conceal an underlying strategic position.

Some arguments against the application of nonuse value are based on what might be described as a different philosophical view of the world. For instance, it is the view of some that individuals do not place a value on nationally significant irreplaceable resources which they do not use. Therefore, in their view, nonuse value simply does not exist.

This philosophical stance has, in fact, found little support in the empirical literature. The preponderance of statistical evidence instead supports the alternate hypothesis. As concluded by Fisher and Raucher (1984:60), "...empirical efforts to measure intrinsic [nonuse] benefits consistently show these nonuse values to be positive and nontrivial."

The majority of reasoned arguments against the incorporation of nonuse value into benefit/cost analyses and damage assessments are based primarily on technical concerns. Specifically, these arguments focus on the broad question of whether nonuse value can be accurately and scientifically estimated using contingent valuation techniques.

The validity and reliability of the contingent valuation method has been examined extensively in the literature (Heberlein and Bishop 1986; Loomis 1989; Kealy, Montgomery, and Dovidio 1990). Nonetheless, substantive questions about the use of CVM remain. Challenges to its use are commonplace and well documented (Cambridge Economics Inc. 1992). While few economists discount nonuse value on theoretical grounds, valid questions about CVM's accuracy and reliability exist and have given rise to vigorous debate among economists and non-economists alike. A nontechnical overview of this discourse is found in the exchange between Carson, Meade, and Smith (1993), Desvousges et al. (1993), and, Randall (1993). We expect that the findings of the NOAA expert panel will focus the nonuse value debate on these technical aspects and away from less fruitful philosophical discussions and strategy based arguments.

NONUSE VALUE AND THE NEPA PROCESS

Applicability

The National Environmental Policy Act of 1969 (NEPA) is triggered when a Federal action is contemplated which may significantly affect environmental quality. "Significantly," as used in NEPA, requires consideration of both context and intensity. Examples of actions which may be considered significant are described in the Council on Environmental Quality's (CEQ) Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act (40 C.F.R. pt. 1500-1508). Indicators of significance include the existence of unique geographical characteristics in the affected local, the degree to which the action is likely to be controversial, the degree to which the action may adversely affect scientific, cultural, or historical resources, and, potential impact on endangered species or their habitats (40 C.F.R. pt. 1508.27(b)). The similarity between the indicators of significance cited in the CEQ regulations and the indicators of nonuse value discussed here and in the literature is remarkable.

If a contemplated Federal action is judged to have significant environmental effects, NEPA prescribes preparation of an environmental impact statement (EIS). The CEQ regulations specify that, "... economic or social effects are not intended by themselves to require preparation of an environmental impact statement. When an EIS is prepared and economic or social and natural or physical environmental effects are interrelated, then the environmental impact statement will discuss all of these effects on the human environment," (40 C.F.R. pt. 1508.14). For impacts to resources for which there is nonuse value, failure to estimate it and report its magnitude would appear to be contrary to the language of the regulations.

Impact assessment and schedule

Development of an effective and technically adequate contingent value survey instrument is conditional on the development of concise and understandable descriptions of expected physical and environmental impacts. Determination of the cultural, physical, biological, and, ecological impacts of the alternatives being examined in an EIS is a substantial undertaking which may require primary data collection, extensive research, and analysis. This dependence has a very important implication for the integration of nonuse value studies in an EIS. Since fact-based, neutral depictions of expected impact cannot proceed until this underlying work has been completed, this necessarily places completion of a nonuse value study at the end of the sequence of EIS activities.

Identification and quantification of resource impacts is the most difficult, most subjective, and quite possibly the most controversial aspect of EIS preparation. Consequently, impact analyses are often not completed until late in the EIS process. If a nonuse value study was contemplated at the outset of the EIS process, sufficient time must be allocated in the schedule to allow for its completion. If completion of a nonuse value study was not envisioned, the study manager is presented with a difficult set of decisions.

In the latter circumstance, one choice open to the NEPA manager is to delay release of the draft EIS until the nonuse value study is completed. This is probably the most conservative course of action, but it may entail substantive delays in the release of the draft EIS document for public comment.

An alternative strategy is to pursue a parallel schedule. Under this strategy, the methodology to be employed in the nonuse value study is described in the draft EIS, but no quantitative results are presented. Typically, for a period of months following the release of the draft document, public meetings are held, comments are accepted and addressed by the EIS team, and revisions to the draft EIS are made. A nonuse value study may be completed during this period presuming that it is initiated as soon as the expected physical and biological impacts have been identified. The quantitative results of the nonuse value study can then be incorporated in the final EIS.

There are two potentially important drawbacks to this course of action. First, public comment is precluded when the quantitative results are reported only in the final EIS. Second, if the results of the nonuse value study are determined to be, "... significant new circumstances or information relevant to the environmental concerns and bearing on the proposed action or its impacts," a supplement to the final EIS may be required (40 C.F.R. pt. 1509(c)ii).

Potential focus of criticism and/or legal challenges

The national debate over the inclusion of nonuse values in natural resource damage assessments and policy applications has focused previously unprecedented scrutiny on all aspects of the topic. Most economists are willing to agree that nonuse value is a theoretical possibility but even among the ranks of economists there are divisions over measurement issues and questions of precision. Among the general public and members of other disciplines there is even less common ground. Consequently, estimation of nonuse value, its classification with other benefits or costs, and the treatment of nonuse value in subsequent analyses must be expected to generate considerable controversy. The possibility exists that such controversy may play into the hands of critics and/or provide a basis for litigation designed to discredit an environmental impact study.

Funding

An important component of the decision to initiate a nonuse value study is the cost of such a study. Significant expenditures must be made on the design and testing of an appropriate survey instrument. Since the resource at issue is presumably one of national significance, it is not unrealistic to envision that the survey instrument will be administered to a random sample of the U.S. population. Survey administration costs and data analysis costs will, of course, reflect this. These costs are likely to be comparable to the costs of research on the environmental consequences of the contemplated action.

For complex EIS's, experience has shown that the costs of necessary hydrological, engineering, biological, geological, and, other physical studies are considerable. In the past, we have observed asymmetric funding of economic investigations compared to studies in these other disciplines. Frequently, large sums are spent on these physical and biological studies and little funding is devoted to economic investigations. As we acknowledge, these economic investigations are critically dependent on the identification of impacts. However, given the potential importance of nonuse value studies in the decision process, a reluctance to devote comparable funding to such investigations seems peculiar and shortsighted.

AN ONGOING APPLICATION

Glen Canyon Dam, on the Colorado River near Page, Arizona, was completed by the U.S. Bureau of Reclamation in 1963 before the passage of NEPA. Even at that time, this project was the subject of an unprecedented nationwide environmental protest.

The daily water release regime at Glen Canyon Dam reflects its operation for the production of peaking power. Historically, this regime has resulted in large daily fluctuations in flow and river stage. Because of concerns that these fluctuations were negatively impacting the downstream environment and recreational use of the Grand Canyon, the Commissioner of the Bureau of Reclamation authorized the Glen Canyon Environmental Studies (GCES) Phase I in 1982. Over 40 separate technical studies were completed by 1988. These interagency studies focussed on the underlying physical and biological processes but also included an extensive study of recreation use value in the area (Bishop et al. 1987).

In July 1989, as a result of impacts to the riverine ecosystem identified in the GCES Phase I program and subsequent concerns expressed by the Congress and the public, then Secretary of the Interior, Manuel Lujan, directed that an EIS be prepared. The Bureau of Reclamation was designated as the lead agency and the National Park Service, the Bureau of Indian Affairs, the U.S. Fish and Wildlife Service, Western Area Power Administration, the Arizona Game and Fish Department, the Hopi Tribe, the Hualapai Tribe, the Navajo Nation, the San Juan Southern Paiute Tribe, the Southern Utah Paiute Consortium, and the Pueblo of Zuni are cooperating agencies (Department of the Interior, Bureau of Reclamation 1994). Additional research, termed the Glen Canyon Environmental Studies Phase II, was commissioned partly to support the EIS.

The majority of the indicators of nonuse value discussed in the literature are present in the Grand Canyon. In 1975, the Grand Canyon was declared by the Congress to be "a natural feature of national and international significance" (Pub. L. 93-620, 16 U.S.C. 228a). It was designated as a World Heritage Site in 1979. The

Colorado River in the Grand Canyon has been proposed as critical habitat for two species of endangered native fish (U.S. Department of the Interior, Fish and Wildlife Service 1994). Visitation to the Grand Canyon National Park is quite extensive and reached 4,547,027 visitors in 1992 (J.M. Mitchell, personal communication). In order to prevent resource damage, alleviate crowding, and ensure public safety, the National Park Service regulates the amount and timing of recreation use in the Canyon. Those on the waiting list for private white-water boating permits must wait approximately eight years, indicating considerable demand in excess of the number of trips allowed through this rationing system.

A National Academy of Science Committee reviewed the scientific adequacy of the Glen Canyon Environmental Studies Phase I. Among other comments, the committee noted that the Phase I GCES economic studies had not considered nonuse value (Committee to Review the Glen Canyon Environmental Studies 1987:94). To address this issue, the cooperating agencies agreed to systematically investigate the feasibility of estimating nonuse value for the Phase II studies.

The Bureau of Reclamation retained an independent consulting firm to evaluate the feasibility of estimating nonuse value for changes in dam operations. As part of this effort, a panel of well known economists was convened to review the consultant's work, to provide written commentary on its technical adequacy, and to provide their views on the prospects for successfully completing a nonuse value study for GCES Phase II. Although some technical and practical concerns were noted, the findings of this panel were in favor of initiating a nonuse value investigation (HBRS 1991). Based on these findings, the cooperating agencies jointly agreed to continue the investigation in a stepwise fashion.

In the next step, a series of focus groups or group discussions were held at eight locations around the country to explore the feasibility of estimating nonuse value for the specific resources affected by operational alternatives. These focus groups were held with small groups of randomly selected individuals in New York, Tennessee, Nebraska, Arizona, and Utah (HBRS 1992).

Participants in these discussions were presented with a summary of the impacts to the affected physical environment resulting from Glen Canyon Dam operations. They were then asked to predict how changes in flow patterns might have affected the river ecosystem in the Grand Canyon. Participants were also asked to indicate the impacts about which they cared most.

Participants were able to distinguish impacts to the river corridor from impacts to the Grand Canyon as a whole. They were able to predict, in a general way, the impacts of releases from Glen Canyon Dam on the downstream ecosystem. Indications were that they care about impacts to vegetation, wildlife, native fish, archeological sites, and, Native American groups currently living near the Grand Canyon. Participants in these discussions expressed a clear desire to undertake actions that would reduce or eliminate the impacts of dam operations.

During the course of this investigation, the question of whether there is some nonuse value for hydroelectric power—a good sold in the market—arose. Potentially, nonuse value could be relevant in this context because of the renewable nature of hydropower, because of impacts on local communities, or due to empathy for the affected population (Department of the Interior, Bureau of Reclamation 1994).

There is only one example that suggests that there may be nonuse value for market goods (Lockwood et al. 1994). Nevertheless, this possibility remains an open question. Consequently, enhancements to the surveys were made to allow this question to be more rigorously examined. Additional focus groups and intensive one-on-one debriefings were held to facilitate these design changes.

The pilot testing phase of the GCES nonuse value study is now underway. The goals of this phase are to (1) explore suitable sampling scheme(s), (2) design appropriate survey instruments, and, (3) test these survey instruments. The findings of this phase of the research

are expected to be available in 1994 and will be described in subsequent GCES reports and in the Glen Canyon Dam final EIS. Based on the outcome of this phase of the research, the cooperating agencies will consider whether or not to proceed with a full scale study of nonuse value as described in Bishop and Welsh (1992a).

CONCLUSIONS

Existing empirical studies demonstrate that nonuse value for resources in which there is widespread interest may be quite large both absolutely and relative to estimates of economic use value. For this reason, inclusion of estimates of nonuse value in economic efficiency analyses may have important implications with regard to water resource management and decision making.

There is a very close correspondence between the indicators of nonuse value discussed in the economic literature and indicators of significant environmental impact that trigger the preparation of an EIS under NEPA. Consequently, at least some subset of Federal actions requiring an EIS may require a treatment of nonuse value. Quantification of nonuse value, if any, along with other economic effects may provide important quantitative information to the decision maker. Potentially, this should allow for a comparison of impacts using the same metric, resulting in a more reasoned assessment of the alternatives being examined.

Our ongoing GCES application has uncovered some technical, practical, and procedural impediments that hinder the smooth integration of nonuse value with the NEPA process. The most important of these factors is the impact on EIS scheduling and work flow. Although these problems have now been identified, solutions and allowances within the NEPA process remain to be developed.

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APPENDIX 2.

ESTIMATION OF ANGLER WILLINGNESS TO PAY FOR IN-STREAM FLOW

1. Economic

During the summer of 1989, approximately 287 anglers in the study area were contacted by survey enumerators and the purpose of the survey was briefly explained to them. At the time they were contacted on-site, anglers were asked only if they would agree to participate in the survey. Over 99.5% of the individuals who were contacted agreed to participate. Their names, addresses, and telephone numbers were recorded by the enumerators.

The mail survey was sent to anglers in October 1989. Mailings, reminders, and follow up mailings followed the methodology described in Dillman (1978). The survey return rate was approximately 84.0%. This return rate is very high and may reveal the importance of this area to resource users. The high rate of return may also reflect the strength of the methodology employed.

Using the data from the survey, the probability of a obtaining a **yes** response was estimated using standard maximum likelihood techniques. The results shown in [1] were obtained:

$$\mathrm{LOG}\left[\frac{P}{1-P}\right] = \underset{(3.67)}{4.69} - \underset{(-9.93)}{0.934}\ \mathrm{LPRICE} + \underset{(2.21)}{0.161}\ \mathrm{LCAT}$$

$$\underset{(-3.38)}{-1.038}\ \mathrm{LAGE} + \underset{(3.82)}{0.516}\ \mathrm{LINC} + e_i \qquad [1]$$

Maddala R^2 = .24 percent of correct predictions = 72%

where: P = probability of a yes (1) response

LPRICE = logarithm of price

LCAT = logarithm of total catch per day

LAGE = logarithm of age of respondent

LINC = logarithm of family income in 1000's

( ) = the numbers in parentheses are asymptotic t-statistics

e_i = random disturbance term

The coefficients for price, income, age, and the constant term are statistically significant at the 99% level of confidence. Total catch per day is significant at the 95% level of confidence. Maddala's R^2, one measure of goodness of fit (Maddala 1983, equation 2.49), indicates that the equation is relatively robust. The percentage of individuals whose response is correctly predicted is approximately 72%.

Repeatedly integrating relationship [1] at different levels of total catch per day yields the expected willingness to pay estimates shown in Table A3-1. The difference between expected willingness to pay, estimated at two different levels of catch, is the marginal value of an additional fish caught. As shown, the marginal value of an additional fish is high for small numbers of fish caught and low for large numbers of fish caught. The mean catch reported by anglers in the study area is approximately 7 fish per day. The value of a one fish increase in the average number of fish caught per day (from 7 to 8) is $0.50 per angler. The total economic value of the fishery at current use and catch levels is ($33.07*10,000) = $330,700 per year.

Both stocked rainbow trout and naturally reproducing brown trout are caught in the Taylor River. Recent work by Johnson and Walsh (1989) suggests that anglers value wild trout more than hatchery reared trout. Since the estimates presented in Table 1 are for a weighted average of both stocked and wild fish, they should be considered lower bound estimates of the value of catching an additional wild fish.

Table A3-1
INDIVIDUAL WILLINGNESS TO PAY
FOR CATCH BY STREAM ANGLERS

Fish	Expected Value ($)	Marginal Value ($/fish)
1	26.50	NA
2	28.70	2.20
3	30.06	1.36
4	31.06	1.00
5	31.85	0.79
6	32.50	0.66
7	33.07	0.56
8	33.56	0.50
9	34.01	0.44
10	34.40	0.40
11	34.77	0.36
12	35.10	0.34

Given the high number of fish reportedly caught by survey respondents, the estimated values obtained in this study are comparable to those reported elsewhere in the literature (Johnson and Walsh 1987, 1989).

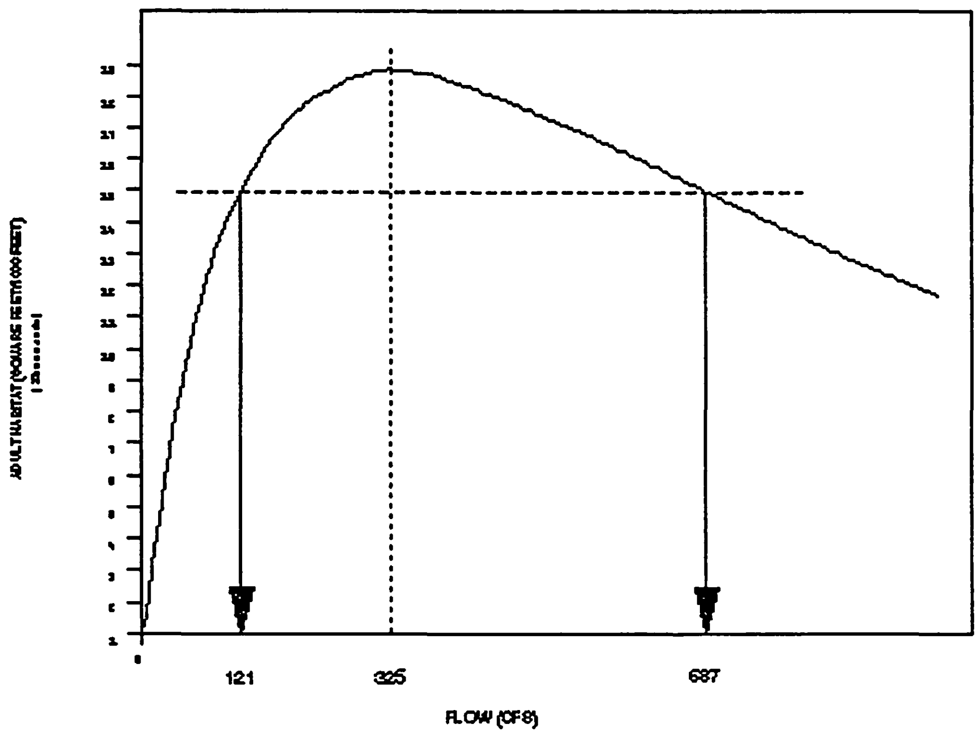

Figure 1. The relationship between adult available habitat and flow. As shown, two different flows may produce the same amount of habitat.

The Effective Habitat Model

The biological data used in this study were collected by the Colorado Division of Wildlife in October of 1979, 1980, 1981, 1982, and again in 1984. Electroshocking was employed to sample the fish population present. The size of the population and its age structure were then estimated. The physical and hydrologic data used in the habitat modelling process were collected by Barry Nehring of the Colorado Division of Wildlife in 1984.

Using the data collected by Nehring and the habitat suitability index curves found in Raleigh, Zukerman and Nelson (1986), physical habitat versus flow relationships for the four life stages of brown trout were estimated. The relationship for adult brown trout is illustrated in Figure 1. As shown in this figure, adult habitat is not a monotonically increasing function of flow. Instead, adult habitat rises as flow increases, reaches a peak at approximately 325 cubic feet per second (cfs), and then falls as flow increases further. Except for the maximum point, there are two flows which will result in the same level of habitat.

Using the methodology described in Harpman (1990), the biological data, the physical data, and a time series of monthly stream discharge were employed to construct an effective habitat model for the Taylor River from the Taylor Park Reservoir to its confluence with the East River. The model was calibrated to observed data using mortality rates. When calibrated, adult brown trout were predicted to exist at a density (η) of 0.061 adults per square foot of adult effective habitat.

THE VALUE OF CRITICAL WINTER FLOW

Framework for Analysis

The effective habitat model is driven by flow which of course is quite variable. The variation in flow can obscure the fundamental relationships reflected by the model. For the purposes of simplifying this analysis a statistical water year is used. This statistical water year is calculated as the mean monthly flow for the years 1952-1988[1]. The resulting hydrograph is shown in Figure 7.2.

Using the flows during the statistical water year to drive the model reveals that, on the average, flows during the months of January and February limit the size of the population. Holding all other flows constant, increasing the flows during this period increases the brown trout population as shown in Figure A3.1. As shown in this figure, the relationship between increased flow during this period and population response is not continuously increasing. In fact, holding all other flows constant, the response function reaches a limit at 121 cfs. This upper limit reflects the fact that another constraint on population growth, a constraint due to high spring flows, has been reached. This limit is illustrated graphically in Figure A3.2 in the preceding chapter. This result has a very powerful implication. It implies that, all other things being held constant, there is no production value to additional summer flow.

---

[1]This is not a stationary series since there was a change in the reservoir operations plan in 1975. However, several extreme flow events occurred during the thirteen year period 1975-1988. For that reason, the entire series 1952-1988 was used to generate the statistical year used in this analysis.

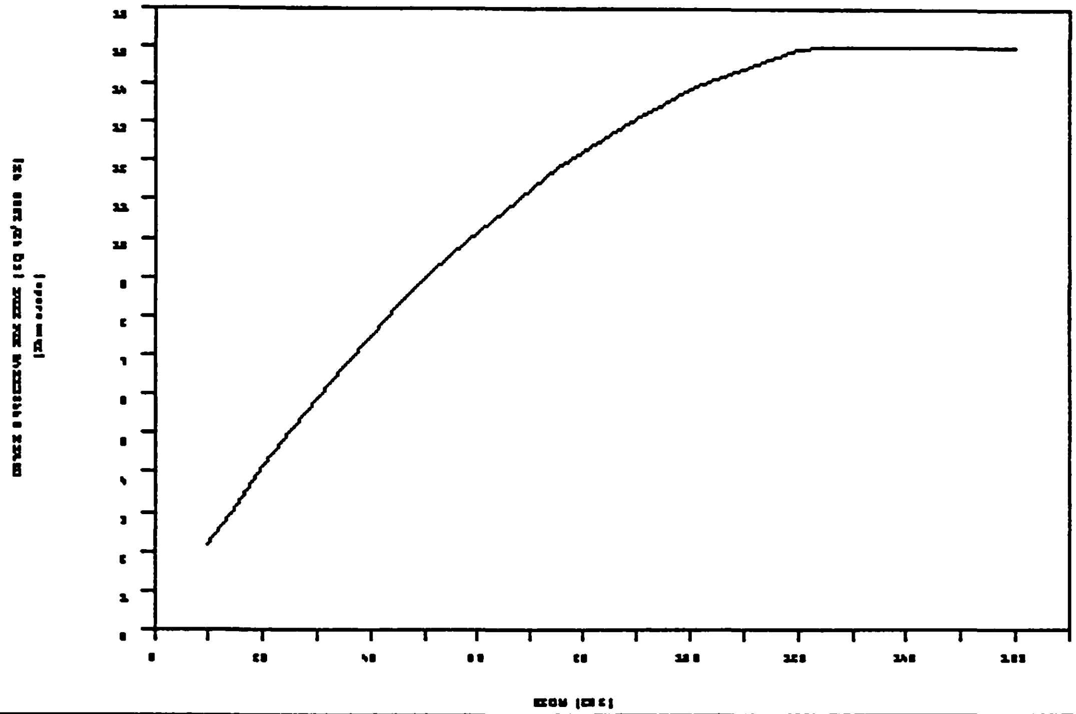

Figure A3.1

Adult Effective Habitat as a Function of Flow in January and February. Calculated from the Statistical Water Year, Holding All Other Flows Constant.

The Value of Winter Flow to Anglers

Increasing the amount of critical winter flow 10 cfs (from 50 cfs to 60 cfs) increases the naturally sustainable population of adult brown trout by 69 fish per 1000 linear feet of river. The population increase over the 21.2 miles of river between the Taylor Reservoir and the confluence of the Taylor with the East River is 7,723 fish. For the purposes of this study it is assumed that anglers will catch[2] approximately 50% of the total sustainable population. A catch to sustainable population

[2]Here, catch is defined as all fish caught by anglers whether kept or released.

multiplier of 0.50 is thus used[3]. Multiplying the total increased population times 0.50 yields 3,861 fish caught. From the willingness to pay analysis, it has been estimated that anglers are willing to pay $0.50 per additional fish caught. If 3,861 anglers catch one additional fish, the increased number of fish caught has a net value of $1,930.64. The net value of flow to anglers (in this flow range) is $1,930.64/10 = $193.06 per cfs. While this figure is quite high, 10 cfs of flow, flowing every second for 2 months, is a substantial quantity of water (1,190 acre feet). On a per acre foot of water basis, the net value of flow (in this range) is $1,903.64/1,190 = $1.63 per acre foot. Table A3.2 shows the value of critical winter flow for several different flow ranges.

---

[3]The magnitude of this multiplier is problematic. The effective habitat model is calibrated based on the observed mortality rates. Observed mortality rates are, in turn, a function of both natural mortality and fishing mortality. Catch, as defined here, is difficult to accurately measure. Clearly, the lower the mortality, and the higher the catch, the larger the multiplier. In some catch and release fisheries where the fish are readily caught this multiplier is undoubtedly greater than 1. In the absence of any pertinent empirical evidence, a magnitude of 0.5 is assumed for this application.

TABLE A3.2
MARGINAL VALUE OF
CRITICAL WINTER FLOW

Flow (CFS)	Per CFS	Per Acre-foot
0	NA	NA
10	$377.25	$3.16
20	$330.14	$2.77
30	$298.39	$2.51
40	$266.30	$2.24
50	$266.30	$2.24
60	$193.06	$1.63
70	$193.23	$1.63
80	$166.60	$1.40
90	$139.98	$1.18
100	$139.80	$1.17
110	$ 87.06	$0.73
120	$ 87.06	$0.73

The values presented in Table A3.2 are, of course, sensitive to the values of several parameters including the marginal value of flow and the catch multiplier. Table A3.3 illustrates the value of critical winter flow between 50 and 60 cfs, which has been calculated at alternative marginal values of catch and catch multiplier. In this Table, the per acre foot values of flow found in each row are calculated at the same marginal value of catch. In each column, the per acre foot values are calculated at the same value of catch multiplier. For example, each value in the first row is calculated at a marginal value of catch equal to $0.10 but at a different level of catch multiplier. Looking at the first row in Table A3.3, the value of $0.45 per acre foot of water is calculated at a marginal value of catch equal to $0.10 and a catch multiplier of 0.7.

TABLE A3.3
SENSITIVITY ANALYSIS OF FLOW VALUE.
MARGINAL VALUE PER ACRE FOOT OF CRITICAL WINTER FLOW
BETWEEN 50-60 CFS. CALCULATED AT ALTERNATE PARAMETER VALUES

Marginal Value of Catch	Value of Catch Multiplier					
	0.1	0.3	0.5	0.7	0.9	1.1
0.10	0.06	0.19	0.32	0.45	0.58	0.71
0.20	0.13	0.39	0.65	0.91	1.17	1.43
0.30	0.19	0.58	0.97	1.36	1.75	2.14
0.40	0.26	0.78	1.30	1.82	2.34	2.86
0.50	0.32	0.97	1.62	2.27	2.92	3.57
0.60	0.39	1.17	1.95	2.73	3.50	4.28
0.70	0.45	1.36	2.27	3.18	4.09	5.00
0.80	0.52	1.56	2.60	3.63	4.67	5.71
0.90	0.58	1.75	2.92	4.09	5.26	6.42
1.00	0.65	1.95	3.24	4.54	5.84	7.14
1.10	0.71	2.14	3.57	5.00	6.42	7.85
1.20	0.78	2.34	3.89	5.45	7.01	8.57
1.30	0.84	2.53	4.22	5.91	7.59	9.28
1.40	0.91	2.73	4.54	6.36	8.18	9.99
1.50	0.97	2.92	4.87	6.81	8.76	10.71
1.60	1.04	3.11	5.19	7.27	9.34	11.42
1.70	1.10	3.31	5.52	7.72	9.93	12.13
1.80	1.17	3.50	5.84	8.18	10.51	12.85
1.90	1.23	3.70	6.16	8.63	11.10	13.56
2.00	1.30	3.89	6.49	9.08	11.68	14.28

As shown in this table, estimates of the value of critical flow are relatively sensitive to changes in the value of catch and the catch multiplier. As previously noted, the value of catch may be related to the origin of the fish caught, i.e; whether they are wild fish or not. This may have important implications for the value of flow. Assume that the average angler on the Taylor River can differentiate between wild and stocked fish and values wild fish (browns) more. Further, assume that the value of an additional brown trout is approximately $1.40 per fish (similar to that reported in Johnson and Walsh 1989 for a wild fish). At a catch multiplier of 0.50 and a marginal value of $1.40 per fish, the value of critical winter flow is then $4.54 per acre foot as shown in Table 7.10.

Appendix 3.

Estimation of Boaters' willingness to pay for flow

Taylor River Boaters' Willingness to Pay for Flow.

After the raw data was processed as described in part 3., the probability of a yes response was estimated using the logit techniques described previously. Using the flows actually experienced by boaters on the Taylor River, the following results were obtained:

$$\text{LOG}\left[\frac{P}{1-P}\right] = -\underset{(-2.23)}{0.5989}\ \text{LPRICE} + \underset{(2.92)}{2.1318}\ \text{LFLOW} - \underset{(-2.29)}{2.3474}\ \text{LAGE} + \underset{(0.41)}{0.3856}\ \text{LSEX} + e_i \qquad [1]$$

Maddala R^2 = .13 percent of correct predictions = 75%

where: P = probability of a yes (1) response

LPRICE = log(price)

LFLOW = log(flow) cubic feet per second

LAGE = log(age) age of respondent

LSEX = log(sex) of respondent (male = 1, female = 2)

( ) = asymptotic t-statistic

e_i = random disturbance term

As shown, the coefficients for price, flow, and age are statistically significant at the 95% level of confidence.

Maddala's R^2, one measure of goodness of fit[1], indicates that the equation is reasonably robust. The percentage of individuals whose response is correctly predicted is approximately 74%.

Repeatedly integrating the estimated relationship [1] at different levels of flow yields the estimates of willingness to pay found in Table A4-1.

TABLE A4-1
INDIVIDUAL WILLINGNESS TO PAY
FOR FLOWS IN THE TAYLOR RIVER
BY WHITE WATER BOATERS

Flow (cfs)	Expected Value	Incremental Value
100	96.63	NA
200	257.32	160.67
300	376.82	119.50
400	451.24	74.42
500	496.71	45.46
600	525.28	28.58
700	543.98	18.70
800	556.71	12.73
900	565.69	8.98
1000	572.23	6.53
1100	577.11	4.88
1200	580.84	3.73
1300	583.75	2.91
1400	586.06	2.31
1500	587.92	1.86
1600	589.44	1.52
1700	590.70	1.26
1800	591.75	1.05

[1] Maddala's R^2 (Maddala 1983, equation 2.44) is defined as $R^2 = 1 - (L_r/L_u)^{2/n}$ where L_r is the restricted likelihood function, L_u is the unrestricted likelihood function, and n is the sample size. Unlike the R^2 calculated in OLS regressions, the upperbound on Maddala's R^2 is much less than 1.0. In fact, since: $1 \geq L_r/L_u \geq L_r/L_{max}$, the upper bound on Maddala's R^2 is described by $0 \geq R^2 \geq 1 - (L_r)^{2/n}$.

NATIONAL FAMILY OPINION, INC.

P. O. Box 474 Toledo, OH 43654

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INSIDE OHIO: 1-800-472-4000

MONDAY THROUGH FRIDAY
8:00 A.M. TO 4:30 P.M.
EASTERN TIME

14389–1

Dear NFO Member,

Today's survey is about a ***dam and water project proposed for western Colorado.***

On the next page you will see a photograph of the proposed project site as it currently exists. Following that is information regarding the project's possible benefits and environmental effects. Please carefully read this information and answer the questions at the end of the survey.

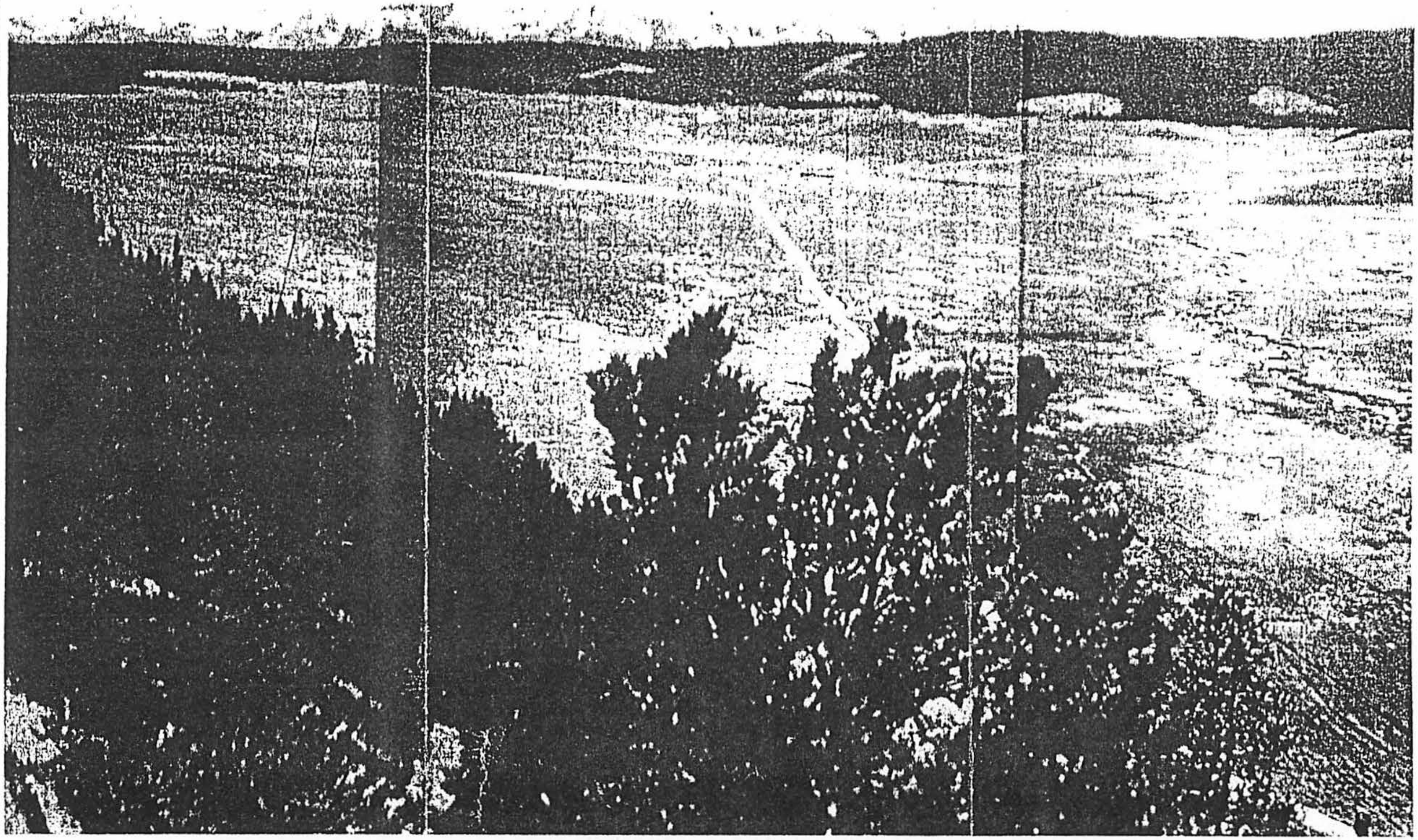
As always, your opinion is very important. Won't you take a few moments now to read and complete this survey? When you are finished, please return the survey to me in the enclosed postage–paid envelope.

Thank you very much for your cooperation!

Sincerely,

Carol

Carol Adams



National Family Opinion, Inc.

14389–1

Arapahoe County has proposed a project which would involve a single large reservoir to be built in the high mountain valley of Union Park. This reservoir would be located approximately 25 miles northeast of Gunnison, Colorado.

POSSIBLE BENEFITS ...

Union Park Reservoir, if built, is projected to be a very large one which would store runoffs from years with very high snowfall. Authors of this project predict that, on the average, enough water would be released to supply approximately 250,000 inhabitants in Arapahoe County with their normal water requirements. In years of very low snowfall, more water could be released in order to make up for the short falls from more traditional sources.

Another feature of the Union Park Reservoir is a plan to store energy during the hours when electric utilities have surplus power. This energy would be saved for use during peak hours when the utilities power supplies are being used to the limit. This could potentially have the effect of keeping electricity bills from rising in Colorado and other western states.

POSSIBLE ENVIRONMENTAL EFFECTS ...

If Union Park Reservoir is built, 3,500 acres would be flooded. This area includes three elk calving grounds used by a herd of 1,500 elk. Also included are pastures for bighorn sheep and mule deer. The habitats of the beaver and muskrat, numerous native and migrating birds and native trout would be disturbed or destroyed. Additionally, an adjacent area studied for possible wilderness designation may be adversely affected by the Union Park Reservoir.

PLEASE ANSWER THE QUESTIONS ON THE BACK PAGE ☞

1. Based on the information you have just read, would you be in favor of the Union Park Reservoir being built <u>or</u> would you oppose its construction? **(CHECK ONE BOX)**

   1 ☐ In favor – **(SKIP TO QUESTION 3)**
   2 ☑ Oppose – **(CONTINUE)**

2. If legislation was introduced to prevent the construction of the Union Park Reservoir in order to maintain the environment as it is now, there could be costs to Colorado residents in the form of higher annual water bills.

   Please consider the possible range of yearly costs listed below.

   In Column A below ... check to indicate at what dollar amount the higher costs to your household would be a ***reasonable price*** to pay in order to protect the environment in this situation. **(CHECK ONE BOX IN COLUMN "A")**

   In Column B below ... check to indicate at what dollar amount the higher costs to your household would ***begin to be too expensive*** but you would still consider paying them in order to protect the environment. **(CHECK ONE BOX IN COLUMN "B")**

   In Column C below ... check to indicate at what dollar amount the higher costs to your household would ***become too high*** to justify protecting the environment in this situation . **(CHECK ONE BOX IN COLUMN "C")**

CHECK THIS BOX ☑ IF YOU WOULD BE UNWILLING TO PAY ANY AMOUNT.

	"A" Reasonable Price	"B" Begin To Be Too Expensive	"C" Become Too High
$1.00 or less	1☐	1☐	1☐
$1.01 to $5.00	2☐	2☐	2☐
$5.01 to $10.00	3☐	3☐	3☐
$10.01 to $25.00	4☐	4☐	4☐
$25.01 to $50.00	5☐	5☐	5☐
$50.01 to $100.00	6☐	6☐	6☐
$100.01 to $200.00	7☐	7☐	7☐
$200.01 to $500.00	8☐	8☐	8☐
Other Amount (Specify)	$______	$______	$______

3. Please indicate your age and sex below.

   AGE: 76 years

   SEX: 1☐ Male 1☑ Female

NATIONAL FAMILY OPINION, INC.

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EASTERN TIME

14389-2

Dear NFO Member,

Today's survey is about a ***dam and water diversion project proposed for western Colorado.***

On the next page you will see a photograph of the proposed project sites as they currently exist. Following that is information regarding the project's possible benefits and environmental effects. Please carefully read this information and answer the questions at the end of the survey.

As always, your opinion is very important. Won't you take a few moments now to read and complete this survey? When you are finished, please return the survey to me in the enclosed postage-paid envelope.

Thank you very much for your cooperation!

Sincerely,

Carol

Carol Adams

Almont Reservoir Site

Pie Plant Reservoir Site

The Collegiate Range Project, proposed by the City of Aurora, would be a trans–mountain diversion of water from a point near Gunnison, Colorado into the South Platte River. Estimates by the City of Aurora and by the Colorado Water Conservancy Board suggest that enough water would be diverted to supply approximately 250,000 new residents in Aurora.

Two reservoir sites are proposed by the City of Aurora:

1. The Almont Reservoir, covering 1,300 acres north of Almont.
2. The Pie Plant Reservoir, covering 980 acres in Taylor Park.

POSSIBLE BENEFITS ...

If built, the Collegiate Range Project would provide the City of Aurora with water supplies to meet projected population growth. In addition, the Almont Reservoir is intended to compensate western Colorado farmers for water taken out of the existing Taylor Park Reservoir.

It is possible that the lake behind Almont Reservoir could support a fish population. It is unlikely, however, that the Pie Plant Reservoir could support a fishery because of daily fluctuations in water levels due to its being smaller and acting as a holding pond for water pumped out of the existing Taylor Park Reservoir.

POSSIBLE ENVIRONMENTAL EFFECTS ...

If the Almont Dam is built, the Roaring Judy Fish Hatchery would be covered with water. The Colorado Division of Wildlife considers this hatchery to be "irreplaceable" *because of its unique natural water supply. In addition, the hatchery is the destination of a salmon migration. Last fall, sports fishermen caught 50,000 pounds of salmon during the migration. There may be adverse effects on bighorn sheep, elk, and deer herds; and 3.9 miles of the East River, between Almont and Crested Butte, would be flooded.*

If the Pie Plant Reservoir is built, elk and deer migration and grazing patterns may be disturbed; beaver muskrat and numerous bird populations could be affected as their habitat could be either disturbed or destroyed. In addition, 2.5 miles of Taylor River would be covered.

PLEASE ANSWER THE QUESTIONS ON THE BACK PAGE ☞

1. Based on the information you have just read, would you be in favor of the Collegiate Range Project being built <u>or</u> would you oppose its construction? (CHECK ONE BOX)

   1 ☐ In favor – (SKIP TO QUESTION 3)
   2 ☒ Oppose – (CONTINUE)

2. If legislation was introduced to prevent the construction of the Collegiate Range Project in order to maintain the environment as it is now, there could be costs to Colorado residents in the form of higher annual water bills.

   Please consider the possible range of yearly costs listed below.

   In Column A below ... check to indicate at what dollar amount the higher costs to your household would be a ***reasonable price*** to pay in order to protect the environment in this situation. (CHECK ONE BOX IN COLUMN "A")

   In Column B below ... check to indicate at what dollar amount the higher costs to your household would ***begin to be too expensive*** but you would still consider paying them in order to protect the environment. (CHECK ONE BOX IN COLUMN "B")

   In Column C below ... check to indicate at what dollar amount the higher costs to your household would ***become too high*** to justify protecting the environment in this situation . (CHECK ONE BOX IN COLUMN "C")

CHECK THIS BOX ☐ IF YOU WOULD BE UNWILLING TO PAY ANY AMOUNT.

	"A" Reasonable Price	"B" Begin To Be Too Expensive	"C" Become Too High
$1.00 or less	1☒	1☒	1☒
$1.01 to $5.00	2☐	2☐	2☒
$5.01 to $10.00	3☐	3☐	3☐
$10.01 to $25.00	4☐	4☐	4☐
$25.01 to $50.00	5☐	5☐	5☐
$50.01 to $100.00	6☐	6☐	6☐
$100.01 to $200.00	7☐	7☐	7☐
$200.01 to $500.00	8☐	8☐	8☐
Other Amount (Specify)	$______	$______	$______

3. Please indicate your age and sex below.

   AGE: 77 years

   SEX: 1☐ Male 1☒ Female