Appendix E

Economic Analysis

Estimation of Visitation and NEV

Net economic use value is a measure of the amount individuals are willing to pay, over and above the costs of participating in a recreation activity. The total net economic value is related to the number of recreationists who participate in each activity, the time of year in which they participate, and the value of each trip taken.

The study by Piper (2007, 2008), of recreation at the Aspinall Project (Blue Mesa, Morrow Point and Crystal Reservoirs) demonstrated the net economic value of recreation varied systematically with the elevation of Blue Mesa Reservoir. This recent, site specific study forms the basis for the quantitative estimates of visitation and net economic value (NEV) of recreation impact presented in this EIS.

Piper (2007) estimated a count data travel cost model using data collected in a 2004 survey administered by Munger and Vinton (2005). More specifically, he estimated a Poisson travel cost model corrected for endogenous stratification. Further details about the model can be found in the sources cited.

In the Poisson model, a response variable y_i denotes the *i*th observation of a non-negative discrete variable with n observations and x_i denotes the corresponding row of the matrix of k regressors, including a constant. The Poisson regression model specifies that y_i given x_i is Poisson distributed with the density function (1)

$$\Pr(Y=y_i) = f(y_i|\lambda_i) = \frac{e^{-\lambda_i}\lambda^{y_i}}{y_i!} \quad (1)$$

and the mean or expected value is given by equation (2)

$$\lambda_i = \exp(x_i'\beta) = e^{\beta_1 + \beta_2 x_2 + \ldots\ldots + \beta_k x_k} \quad (2)$$

In (1), $\Pr(Y= y_i)$ is the probability of y occurring for sample observation i, λ is the Poisson distribution parameter, x' is a vector of explanatory variables and β a parameter vector. The exponential form implies that a change in $x'\beta$ required to get a one unit of increase in y is smaller the further we move from zero. The parameters are estimated using a maximum likelihood estimator. The log likelihood function for the Poisson model is shown in expression (3).

$$\ln LF(\beta) = \sum_{i=1}^{n} \{y_i (x_i'\beta) - \exp(x_i'\beta) - \ln y_i\} \quad (3)$$

In the econometric model he used, the log-linear visitation relationship was specified as shown in (4).

$$\ln \lambda = \beta_0 - \beta_1 \, TC + \ldots \beta_n X_n \,, \qquad (4)$$

Equation (4) is a log-linear demand function. This demand function relates the number of trips to the recreation site taken by each household during the year (λ) to the price or travel cost (TC) and a variety of other explanatory variables. Consumer surplus is the area under the demand function (4) between a price of zero and the mean price paid by recreators.

Integrating equation (4) with respect to TC, from 0 to the mean TC, yields the per household consumer surplus during the recreation season or (5).

$$CS_{HH} = \frac{e^{\beta_0 + \beta_1 TC + \beta B_2 + \ldots + \beta_n}}{-\beta_1} \qquad (5)$$

Recall that λ is the number of trips, per household, taken to the recreation site. The consumer surplus per household per trip is then equal to (6):

$$CS = -1/\beta_1 \,. \qquad (6)$$

The estimated coefficients for this model and the means of the variables used in the model are shown in Table 11.

Table 2. Model Coefficients and Mean Values

Variable	Units	Estimated Coefficient[36]	Mean of Variable
constant	intercept term	-176.93580	1.0
Travel cost	Cost[37] per Trip (2004$)	-0.005768	$224.00
Age	Age of respondent (years)	-0.00231	49.85
Income	HH[38] Income (2004$)	0.00000845	$57,492.00
elevation	Blue Mesa elevation (ft)	0.023878	7492.3

During the 2004 recreation season (May through September), there were 788,625 recreational visits[39] recorded at the Aspinall Project (National Park Service 2008). Using the mean elevation for the 2004 recreation season (7491.67 ft), and the means of the other

[36] The estimated coefficients shown here are from Piper (2007) Table 6, Poisson model results for current scenario data, adjusted for endogenous stratification.
[37] Round-trip travel cost per household per trip. Travel cost components and their calculation are detailed in Piper (2007).
[38] HH is an abbreviation for household.
[39] Defined as one person taking a trip. The duration of a trip could be 1-hour or several days.

variables, the travel cost model predicts the average household visited the Aspinall Project on 2.7798037 occasions in 2004.

Based on the number of recreational visits in 2004 (788,625), the predicted number of household visits to the Aspinall Project in 2004 (2.7798037) and the mean household size (2.4), an estimated 118,207.5375 households visited the Aspinall Project in 2004.

Unlike many travel cost models, the consumer surplus per trip estimated with the Poisson model is independent of the number of trips taken. This is illustrated in equation (6). Using equation (6) and the estimated coefficient for TC, shown in Table 11, the 2004 consumer surplus is estimated to be $72.24 per person per trip (in 2004 dollars).

Discounting Procedures

The costs and benefits of most environmental policies are incurred at different times over what are frequently long time horizons. A fundamental concept in finance and economics is that the timing of benefits and costs makes a difference in the attractiveness of an investment. All other things being equal, one would prefer to receive the benefits of an investment as soon as possible and to pay the costs as far out in the future as possible. Given the choice between receiving $100 today or $100 a year from now, most people would prefer $100 today. Alternatively, if given the choice between paying out $50 today or one year from now, most of us would prefer the latter.

Because the timing of these costs and benefits differs across alternatives, responsible policy choice requires the use of appropriate techniques to allow for commensurate comparisons. Typically, the present value of the future stream of costs and benefits for each alternative is computed and the results arrayed for decision-makers.

Discounting is the methodology used for finding the present value of a cost or benefit that occurs at some time in the future. The process of “discounting” is used to make costs or benefits which occur at different points in time commensurate with each other.

Although the mechanics of the discounting process are very straightforward, the magnitude of the discount rate greatly influences the degree to which future costs and benefits “count” in the decision. As a result, the choice of discount rate is the subject of much controversy.

The literature on discounting and the choice of discount rate is rather vast. Many modern economics texts contain synopses of this literature (e.g. Tietenberg 2006). A more lengthy assessment can be found in the Environmental Protection Agency *Guidelines for Preparing Economic Analyses* (2000).

Summarizing this literature, most economists recommend the real risk-free discount rate for the analysis of environmental programs. A perplexing complication is the real discount rate is not directly observable. However, empirical estimates of the real discount rate commonly lie in a range from 1 percent to 5 percent.

The majority of water resource agencies, including the Bureau of Reclamation, are required to use the so called project evaluation rate in their analyses. The determination of this rate is specified by the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (U.S. Water Resources Council 1983). This rate is calculated annually and published in the *Federal Register*. The project evaluation rate for fiscal year 2008 is 4.875 percent.

As described, the project evaluation rate is, quite clearly, a nominal discount rate. In simple terms, a nominal discount rate is composed of two components: a real interest rate component and an inflation rate component (see note 1 below). The real interest rate is the money paid for the use of capital, expressed as a percentage per period that does not include a market adjustment for the anticipated general price inflation rate in the economy. It represents the time value change in future cash flows based only on the potential real earning power of money. The inflation rate is the percentage rate of change of the aggregate price level from one period to another.

To make this analysis consistent with the recommendations of most professional economists, all costs and benefits are inflated by an escalation rate of 2.20 percent per annum. For a nominal discount rate of 4.875 percent, this process is equivalent to employing a real discount rate of 2.617 percent (see note 1).

The base year chosen for this analysis is 2008. All economic value estimates reported in this document are measured in 2008 dollars.

In summary, the discounting process employed in this analysis conforms to the process described in U.S. Water Resource Council (1983), Environmental Protection Agency (2000) and the recommendations of professional economists. The selected base year for this project is 2008 and the estimated costs and benefits occurring in 2008 are not discounted (or escalated). All subsequent annual costs and benefits are escalated at 2.2 percent per annum and discounted back to the 2008 base year using a discount rate of 4.875 percent.

Note 1. Discount Rates—Real, Nominal and Inflation Rate Components.

A nominal discount rate (DR) is composed of two components: a real interest rate (r) component and an inflation rate component (i). The relationship of a nominal discount rate to the real interest rate and the inflation rate is shown in equation (1).

$$DR = [(1+r)\times(1+i)-1] \qquad (1)$$

where:

$\boldsymbol{DR}$ = (nominal) discount rate
$\boldsymbol{r}$ = real rate of interest

i = inflation rate

Quite often, you see this relationship incorrectly characterized as DR = r + i. However, this procedure is incorrect and, depending on the magnitude of i and r, can lead to significant errors in calculations.