Journal of Environmental Management (1995) **44**, 233–247

Estimating Recreation Employment Effects with IMPLAN for the Glen Canyon Dam Region

Aaron J. Douglas* and David A. Harpman†

**National Biological Survey, Midcontinent Ecological Science Center, 4512 McMurry Street, Fort Collins, Colorado 80525-3400, U.S.A. and †U.S. Bureau of Reclamation, Denver Federal Center, D-5810, P.O. Box 25007, Denver, Colorado 80225-0007, U.S.A.*

Received 20 *May* 1994

Natural resource economists have estimated nonmarket benefits provided by streamflows in a number of recent research papers. However, the literature on instream flow nonmarket benefits focuses on nonmarket recreational benefits, but has not addressed the panoply of benefits provided by rivers and streams. The current paper also considers the economic implications of water-based recreational activities. The analysis uses a software package and database called IMPLAN to estimate the jobs impacts of expenditures for recreation trips to the Lee's Ferry site on the Colorado River. Much of the policy significance of the estimates is that a jobs index is better appreciated by the public than any other measure of economic welfare. The discussion describes the basic input–output model and water-based recreational activities at the Lee's Ferry site. Non-resident Colorado River recreation trip expenditures to the Glen Canyon Dam region generate 585 jobs. The estimates presented here add further credence and policy weight to the assertion that the outdoor recreation sector of the economy is relatively labor intensive.

Keywords: IMPLAN, expenditure, employment, Colorado River.

1. Introduction

Recreation expenditures by anglers and whitewater rafters support jobs and gross business revenues (Cordell *et al.*, 1990). We document the magnitude of the jobs produced by these expenditures. In particular, we make employment estimates for recreation trip-related expenditures to the Lee's Ferry site on the lower Colorado River. Jobs estimates for the Lee's Ferry site are obtained from the Impact Analysis for Planning model (IMPLAN) recently developed by the U.S. Forest Service (Taylor *et al.*, 1992). Recent research quantifies the nonmarket economic benefits from instream flows and notes that they should be considered in market versus nonmarket water allocation conflicts (Walsh, 1980; Daubert and Young, 1981; Bishop et al., 1987; Loomis *et al.*, 1990; Olsen *et al.*, 1991). The dollar benefits provided by various nonmarket

0301–4797/95/030233 + 15 $12.00/0

instream flow recreation activities are comparable with dollar measures of the social benefits provided by market diversionary uses (Douglas, 1988; Loomis *et al.*, 1990). Estimates of instream flow benefits reflect and sharpen the public's appreciation of the nation's water resources (Reisner, 1988).

Jobs estimates for outdoor-related recreation expenditures deepen the public's appreciation of the United States water resources. Jobs are perhaps better appreciated by the public than any other economic yardstick. The economic literature on jobs and water-based recreation expenditures at outdoor sites includes papers by Boyle and Bishop (1984), Bergstrom *et al.* (1990), Cordell *et al.* (1990), and Colby *et al.* (1992). Natural resource economists are responding to the challenge of public persuasion and communication in the papers cited. Estimates of the jobs provided by water-based recreation activities counter false impressions that the preservation of natural resources entails a loss of jobs (Reisner, 1988). Note, however, that jobs and benefits estimates are not closely related. Economists distinguish carefully between expenditures on a good or service and the benefits provided by that service (Just *et al.*, 1982). Site-specific estimates of nonmarket benefits provided by an outdoor recreation site measure the aggregate willingness-to-pay above and beyond aggregate private expenditures for the use of the site (Just *et al.*, 1982). Because admission fees to publicly owned sites are typically small, aggregate social benefits generated by the site are often large. A sizeable increase in admission fees at a river-based recreation site may induce increased expenditures on trips to the site. But the increase in costs will extract some of the nonmarket benefits provided by the site.

2. Jobs and expenditures

Total trip expenditures are, however, of paramount importance in any analysis of the jobs generated by trips to an outdoor recreation site. The ratio of jobs to expenditures measures the relative labor intensity of sectoral or regional output. IMPLAN estimates of the sector multipliers provide precise measures of relative labor intensity for various regional sectors. Unfortunately, the relation between the linear input–output model and multiplier estimates is complicated. A simple estimate of the number of jobs in a sector or region can be devised by constructing the jobs per million dollars of expenditure ratio for the nation. A naive jobs-impact estimate for the region in question can be derived by simple arithmetic if one assumes that this ratio is constant across all regions and sectors. Moreover, this naive estimate provides a yardstick for the more refined jobs per dollar estimates provided by IMPLAN. If the local economy for the region in question is relatively labor intensive, for example, the jobs per million dollars of expenditure ratio generated by IMPLAN will be higher than for the national average.

IMPLAN can make regional job estimates for 1985. This means that 1985 regional data were put into an IMPLAN database. However, the job estimates made here were for 1990 regional data. Thus, the 1990 ratio of jobs to expenditures or output is a useful yardstick for the ensuing analysis (U.S. Bureau of the Census, 1991). In 1990, nominal GNP was $5525 billion, while nominal NNP was $4930 billion (U.S. Bureau of the Census, 1992). The number of jobs was 119·6 million. About 21·64 jobs were produced by a million dollars of GNP in 1990. The labor input required to produce a million dollars of NNP in 1990 was about 24·25 jobs. A similar procedure can be used to derive the number of jobs generated by a million dollars of GNP or NNP in 1985. Inflation induced a noticeable decline in the number of jobs produced by a million dollars of nominal GNP and NNP between 1985 and 1990.

TABLE 1. Expenditures by recreational activities at Lee's Ferry (HBRS, 1991; Cherry, 1993; Riley, 1993; Ritenour, 1993)

	Number of 1991 trips by users living outside the region	Estimated trip expenditures by non-residents in 1990 dollars	Estimated trip expenditures by non-residents in 1985 dollars
Day-use rafters	32 816	2 431 525	2 001 776
Glen Canyon anglers	10 270	2 336 780	1 923 776
Private whitewater rafters	2926	1 836 651	1 512 040
Commercial whitewater rafters	13 478	23 362 147	19 233 106

Grand 1990 total of expenditures over all categories: $29 967 103.

TABLE 2. Recreation trip expenditures at Lee's Ferry by activity and expenditure category in 1985 dollars (HBRS, 1991)

Category	Day-use raft	Anglers	Commercial raft	Private raft
Raft fee ($)	52·00	0·00	901·70	0·00
Gas and oil ($)	0·00	39·70	39·77	67·90
Airfare ($)	0·00	9·13	183·48	41·58
Car rental ($)	1·00	0·47	23·68	3·77
Grocery ($)	1·00	26·51	15·19	145·39
Restaurant ($)	0·00	13·06	60·24	16·15
Personal gear ($)	6·00	0·00	77·58	58·87
Lodge/private ($)	0·00	6·02	79·23	4·81
Lodge/public ($)	0·00	18·06	4·17	19·26
Boat gear ($)	0·00	0·00	0·00	92·24
Fish license and gear ($)	0·00	19·75	0·00	0·00
Guide fee ($)	0·00	13·24	0·00	0·00
Equipment rental ($)	0·00	6·45	0·00	25·41
Other ($)	2·00	34·93	41·96	41·38
Total ($)	61·00	187·32	1427·00	516·76

Both the 1985 and 1990 ratios of jobs to a million dollars of nominal expenditures are relevant for the current analysis. The data on total expenditures for each of the four water-based recreation categories listed in Table 1 is in 1990 dollars. The trips actually occurred in 1991. Hence, $29 167 103, the grand 1990 total expenditures for all categories in Table 1, can be used as a yardstick for comparison with the IMPLAN estimates by using the 1990 ratio of jobs to a million dollars of expenditures. The last column listed in Table 1 is 1985 non-resident trip expenditures. The 1985 grand total trip expenditures by non-residents sum to $24 670 698. To convert 1985 dollars to 1990 dollars, the consumer price index for 1985 (107·6) and 1990 (130·7) was used (U.S. Bureau of the Census, 1991). The naive job estimates obtained with these numbers are 669 jobs (1985 GNP data) and 631 jobs (1990 GNP data) (U.S. Bureau of the Census, 1991; 1992). A tacit assumption underlying the naive estimates is that all of the recreation trip expenditures by non-residents occur in the economic impact zone.

The reason that 1990 dollars of expenditures—rather than 1991 dollars of expenditures—are entered in Table 2 is that IMPLAN does not make 1991 job estimates.

The 1985 version of IMPLAN makes 1985 and 1980 job estimates. The 1990 version makes 1990 or 1985 job estimates. The data that are actually put in the IMPLAN program are 1985 data because the expenditure profiles are from 1985. The expenditure profile data were gathered by HBRS. The expenditure estimates for 1991 trips were constructed by multiplying 1985 trip expenditure values by the number of 1991 trips. Note that IMPLAN has a deflator or inflator for each of the expenditure categories in Table 2. Thus, the data should be entered into IMPLAN for the year in which the expenditures actually occurred. For reasons that are given in detail later in this paper, the jobs estimates presented here do not support any changes in flows.

3. Input–output models

IMPLAN is a sophisticated software package that makes regional input–output models and regional economic impact forecasts based on these models. It is widely used by government agencies to make regional economic forecasts (Miller and Blair, 1985). A national input–output model is based on the premise that the economy can be decomposed into aggregate sectors. The conventional seven-sector model of the United States economy includes an agriculture, mining, construction, manufacturing, transportation, and services sector. All economic activity that does not fall within one of these six sectors is placed in the "other" sector (Miller and Blair, 1985; Taylor *et al.*, 1992). The input–output model is a tabular representation of output flows from each of several industries or sectors and the flows of inputs to various industries or sectors.

The dollar value of the transactions flows from one industry to other industries are represented as a transactions matrix, which is the **A** matrix in equation (4). IMPLAN and other large-scale input–output models incorporate other tabular data arrays including tables of make and use coefficients. The make matrix is a rectangular matrix that lists the outputs of each industry. It is rectangular because an industry may produce a primary good or service as well as several by-products (Taylor *et al.*, 1992). The use matrix contains the value of commodities used by each industry. If the make matrix has n rows and m columns, the use matrix will have m rows and n columns (Taylor *et al.*, 1992). The following discussion assumes that each industry makes one product. Let x_i represent the sales of industry i;

$$x_i = z_{i1} + z_{i2} + \ldots + z_{in} + y_i; \quad i = 1, \ldots, n. \tag{1}$$

The numbers $z_{ij} \geq 0$ represent sales from industry i to industry j; y_i represents the dollar value of sales from industry i to final demand units such as government or foreign exports. Sales to households are often included as final demand sales, but may be treated as an interindustry transaction. The model assumes that the production technology is linear for all sectors for the economy. If all of the sectors of the economy are represented by an equation such as (1), the equations can be given a useful matrix interpretation. Decomposing the industry output in this fashion for all of the sectors of an economy generates n such equations. Thus, this set of n equalities can be represented in matrix notation as:

$$\mathbf{x} = \mathbf{Z} \cdot \mathbf{1} + \mathbf{y}; \quad \mathbf{1} = \begin{vmatrix} 1 \\ 1 \\ \ldots \\ 1 \end{vmatrix}. \tag{2}$$

In equation (3), the numbers a_{ij}, $1>a_{ij}\geq 0$, represent the ratio of the dollar value of sales from industry i to industry j to the total output of industry j; the a_{ij} are assumed to be constants in equation (3):

$$a_{ij}=\frac{z_{ij}}{x_j}, \quad i,j=i,\ldots,n. \tag{3}$$

From equations (2) and (3), a matrix **A** with entries a_{ij} can be introduced,

$$\mathbf{A}=\|a_{ij}\|,\ z_{ij}=a_{ij}x_j,\ \mathbf{Z}\cdot\mathbf{1}=\mathbf{A}\cdot\mathbf{x}. \tag{4}$$

From equations (2), (3), and (4),

$$\mathbf{x}=\mathbf{A}\cdot\mathbf{x}+\mathbf{y},\ \ \mathbf{x}-\mathbf{A}\cdot\mathbf{x}=\mathbf{y}. \tag{5}$$

Using the fact that **A** is square,

$$(\mathbf{I}-\mathbf{A})\cdot\mathbf{x}=\mathbf{y}, \tag{6}$$

and

$$\mathbf{x}=(\mathbf{I}-\mathbf{A})^{-1}\cdot\mathbf{y}. \tag{7}$$

Equation (7) is closely related to economic impact analysis as performed by IMPLAN. IMPLAN estimates the output vector needed to sustain a given vector of final demands. In equation (7), the vector of outputs is a linear function of the "impact" or final demand vector.

There is a useful dual interpretation of the columns of **A**. The columns of **A** represent the rate at which sales from the various sectors produce good j. That is, the production function for x_j is:

$$x_j=F(z_{1j},z_{2j},\ldots,z_{nj}). \tag{8}$$

If all $a_{ij}>0$, then the simple input–output production function is:

$$x_j=\frac{z_{1j}}{a_{1j}}=\frac{z_{2j}}{a_{2j}}=\ldots=\frac{z_{nj}}{a_{nj}}. \tag{9}$$

If there are no sales from sector i to sector j, $z_{ij}=0$ for $x_j>0$ but finite, and $a_{ij}=0$. If $a_{ij}=0$, equation (9) must be replaced with:

$$x_j=\mathrm{Min}\left(\frac{z_{1j}}{a_{1j}},\ \frac{z_{2j}}{a_{2j}},\ldots,\frac{z_{nj}}{a_{nj}}\right). \tag{10}$$

Employment impacts are estimated by pre-multiplying the calculated vector of final outputs by a diagonal matrix of employment coefficients. Let **e** be a column vector of labor inputs, **c** a vector of fixed labor coefficients for each industry, and **C** be a diagonal matrix formed by the components of **c**. Then:

$$\mathbf{C}=\begin{vmatrix} c_1 & 0 & \dots & 0 \\ 0 & c_2 & \dots & 0 \\ \dots & \dots & \dots & \dots \\ 0 & 0 & \dots & c_n \end{vmatrix}, \quad c_i \geq 0,\ i=1,\dots,n. \tag{11a}$$

Let E be the labor input for the economy; from equation (11a):

$$E=\sum_{i=1}^{n} e_i, \quad \mathbf{e}=\mathbf{C}\cdot\mathbf{x}=\begin{vmatrix} e_1 \\ e_2 \\ \dots \\ e_n \end{vmatrix}. \tag{11b}$$

Economic impact analysis begins with some regional or national set of economic expenditures. The more components the economic impact vector has and the larger the matrix **A**, the more sophisticated the model and the impact estimates. The entries for **A** are all non-negative, and less than unity. The column sums for **A** are also less than unity for regional and national input–output models. The reason that the column sums are less than unity is that some sectors of the economy are exogenous to the model. These sectors include the export, government, and household sectors. There are also some expenditures categories such as gross domestic private investment that are excluded from the model. The household sector is the most important sector that is excluded from the model because labor is typically the most important factor input.

On the other hand, the household sector can be incorporated into the model by adding an additional bottom row and final column to the matrix. The elements $z_{i(n+1)}$ represent sectoral sales to households. The elements $z_{(n+1)j}$ represent sales from the households to other industries. Incorporating the household sector into the model is called "closing the model" with respect to households. Incorporating the household sector will increase the size of the components of the matrix inverse:

$$\mathbf{L}=(\mathbf{I}-\mathbf{A})^{-1}. \tag{12}$$

The right-hand side of equation (12) is often called the "Leontief inverse". The column sums of **A** will still sum to less than unity if the model includes households because the government sector, private gross domestic investment, and exports are excluded from the model.

The **A** matrix for IMPLAN includes 528 output sectors. Another pertinent feature of the model is the degree to which the model is adapted for regional impact analysis. Each region imports some of its inputs from and exports some of its outputs to other regions. Hence, one way to adapt the Leontief model for regional impact analysis is to estimate the percentage of each sector's inputs that are produced within the region. This can be accomplished, for example, by pre-multiplying **A** by a diagonal matrix with positive entries that are the percentage of region's outputs that are purchased within the region (Miller and Blair, 1985).

4. Colorado River recreation and expenditures

The data on the number of trips to the Lee's Ferry region for the various recreational

categories was provided by the National Park Service for whitewater rafting (Cherry, 1993) and day-use rafting (Ritenour, 1993). The Arizona Department of Game and Fish supplied data on angling trips (Riley, 1993). The data on mean expenditures per trip were provided by HBRS, a consulting firm (HBRS, 1991). HBRS gathered data from on-site interviews in 1985 that were used by Bishop *et al.* (1987) to estimate flow-related nonmarket recreation benefits on the Colorado River below Glen Canyon Dam. The data on 1985 trip-related expenditures were tabulated across four major recreation categories, including angling, day-use rafting, private whitewater rafting, and commercial whitewater rafting. The 1985 expenditure data collected by Bishop *et al.* (1987) were combined with 1991 National Park Service and Arizona Game and Fish Department data to estimate 1990 jobs impacts. We assume that real per trip expenditures for the various expenditure categories were identical for 1985 and 1991.

The construction of the Glen Canyon Dam in 1964 created a major recreational fishery at the site. The bottom releases from the dam lowered the water temperature and silt loads, thereby creating suitable rainbow trout habitat and a coldwater fishery (Janisch, 1985; Richards and Wood, 1985). Rainbow trout were introduced into tributaries of the Colorado River in the 1920's and 1930's long before the construction of the dam (Baucom, 1992). The current recreational fishery below the dam is also sustained, in part, by some natural reproduction. Unlike the rainbow trout in the tributaries, the self-reproducing contingent of the recreational fishery would not survive the demise of the dam (Baucom, 1992).

The Glen Canyon Dam also stabilized the downstream flows which, before the dam, ranged from highs of 120 000 cubic feet per second (cfs) during the late spring and early summer to 1600 cfs in the fall. Flows range from 3000 cfs to 40 000 cfs after the construction of the dam. Diminished fluctuations in downstream flows were another consequence of the construction of the dam that has had a major positive impact on recreational uses of the Colorado River (Lavender, 1985). Whitewater boating on the Colorado River is a $12 million a year industry that was created in part by the stabilization of flows caused by the construction and operation of the dam (Lavender, 1985). Whitewater rafting activities in the Glen Canyon Dam region are directly or indirectly regulated. Commercial whitewater boating trips may be purchased through guide companies. Private whitewater boating permits may be obtained directly from the National Park Service. Colorado River whitewater rafting trips purchased from 17 licensed outfitting companies supply roughly 80% of the whitewater rafting days on the lower Colorado River (Cherry, 1993). The number of annual private whitewater user days cannot exceed 54 450; the number of annual commercial whitewater user days is restricted to 115 500 (Grand Canyon National Park, 1989). Angling participation days are not currently limited.

There is another type of recreationist—the day-use rafters—who began to visit the Lee's Ferry region after the construction of the dam (Wilderness River Adventures, n.d.). The day-use rafters take 1-day 15-mile excursions on the river. Wilderness River Adventures supplanted the Fort Lee Company as the only concessionaire authorized by the National Park Service to provide these excursions (Ritenour, 1993). At low to moderate flow levels, the trips originate at the base of the Glen Canyon Dam, and terminate at Lee's Ferry. At high flow levels, they begin at Lee's Ferry, and the rafts motor upstream. The passengers do not see the dam from the river on trips that begin at Lee's Ferry. Day-use rafting trips are not limited by the Park Service.

Incomes earned outside the region, but spent within the region, have a greater economic impact than do expenditures by area residents. Therefore, data on the number

TABLE 3. Aggregate 1991 impact zone expenditures for trips to Glen Canyon Dam region in 1985 dollars (HBRS, 1991)

Category	Day-use raft	Anglers	Commercial raft	Private raft
Raft-fee ($)	1 706 432	0·00	5 105 307	0·00
Gas and oil ($)	0·00	203 860	268 010	99 338
Airfare ($)	0·00	0·00	0·00	0·00
Car rental ($)	0·00	4827	319 159	11 031
Grocery ($)	32 816	136 129	204 730	106 353
Restaurant ($)	0·00	67 063	816 632	11 814
Personal gear ($)	196 896	0·00	522 879	172 254
Lodge/private ($)	0·00	61 825	800 896	14 074
Lodge/public ($)	0·00	185 476	42 152	56 355
Boat gear ($)	0·00	0·00	0·00	0·00
Fish license and gear ($)	0·00	81 133	0·00	0·00
Guide fee ($)	0·00	0·00	0·00	0·00
Equipment rental ($)	0·00	33 121	0·00	37 175
Other ($)	65 632	179 366	0·00	121 078
Total ($)	2 001 776	952 800	8 079 765	629 472

Grand total = 11 663 813.

of trips to the site that originate outside the impact area is essential in obtaining an accurate estimate of the economic impacts of recreation site expenditures. The economic impact region for the Lee's Ferry site study is Coconino and Mojave counties in Arizona.

The percentage of 1985 Glen Canyon Dam trips originating outside the economic impact region was extrapolated to 1990 and 1991 (HBRS, 1991). One should have expenditure data that meets certain criteria when making jobs impacts estimates with IMPLAN. First, a detailed expenditure profile—the aggregate expenditure vector—across several expenditure categories is needed. Second, the percentage of the expenditures that occur in the economic impact zone for each category should be available. The HBRS–National Park Service–Arizona Department of Game and Fish 1985 data incorporates estimates of the percentage of the expenditures occurring within the economic impact region. The expenditure percentages that are listed here are based on perusal of the HBRS survey data and knowledge of the site and activities (HBRS, 1991). Cordell *et al.* (1990) assumed that the percentage of expenditures spent within the economic impact zone is determined by the travel distance to the economic impact region, and that the fraction of expenditures that occur within the impact zone is the same for all expenditure categories. The mean travel distance to the economic impact zone for the activity in question was assumed to be the primary determinant of the fraction of expenditures that occur within the impact zone for most expenditure categories for the current study. However, knowledge of the site and the activities suggest that the fraction of expenditures that occur within the economic impact zone for certain recreational goods and services was much higher than for other goods and services. Hence, the fraction of expenditures that occur within the impact zone was assumed to be close to or equal to one for certain types of recreational expenditures (see Table 3).

5. Input–output multipliers

The multipliers for the analysis are structural; they are completely determined by the regional economy. There is, however, a bewildering array of multipliers. Space limitations preclude discussion of many of the pertinent multiplier concepts here. The column sums of an input–output model are non-negative and sum to less than unity. If the column sums of the coefficients in the matrix **A** are less than unity, then the Leontief inverse can be obtained from the power series expansion in equations (13a)–(13b)

$$\lim_{n\,)\,\mathrm{x}} (\mathbf{A})^n = \mathbf{0}, \quad \sum_{i=i}^{\mathrm{x}} (\mathbf{A})^n = \mathbf{Q}, \tag{13a}$$

and

$$(\mathbf{I}-\mathbf{A})^{-1} = \mathbf{I} + \sum_{i=1}^{\mathrm{x}} (\mathbf{A})^n = \mathbf{I} + \mathbf{Q}. \tag{13b}$$

The scaler quantity, y, that represents the magnitude of exogenous expenditures is represented by **y**, a vector whose components sum to y, in making job impact estimates. Using equation (13a), the total impact of **y** can be partitioned into direct effects and indirect effects. The direct or initial effect is given by the first term on the right-hand side of equation (14), $(\mathbf{I}\cdot\mathbf{y})$;

$$(\mathbf{I}-\mathbf{A})^{-1}\cdot\mathbf{y} = \mathbf{I}\cdot\mathbf{y} + \sum_{i=1}^{\mathrm{x}} (\mathbf{A})^n\cdot\mathbf{y} = \mathbf{I}\cdot\mathbf{y} + \mathbf{Q}\cdot\mathbf{y}. \tag{14}$$

The sum of the subsequent terms, $(\mathbf{Q}\cdot\mathbf{y})$, is the indirect effect, and the total effect is the sum of the direct and indirect effects.

The total output effect or "multiplier" is always greater than unity because the Leontief inverse has diagonal elements that are greater than unity. If a column and row representing sales and purchases of households is added to the model, the column sums of the expanded Leontief matrix are larger than the column sums of the original matrix. Also, all of the column sums of the Leontief inverse are increased by closing off the model with respect to households, and the total output effect becomes larger. The "induced effect" is another consequence of closing the model off with respect to households (Miller and Blair, 1985). If household payments and purchases are included in the model, the labor input induced by a dollar of exogenous expenditure and the corresponding household income increment must be positive. The increase in household incomes in turn "induces" an increase in expenditures on the output of the other sectors. The various output effects are called multipliers; thus, there are indirect, induced and total output multipliers for each sector.

There are also income and employment effects and income and employment multipliers. Moreover, there are Type I, Type II, and Type III income and employment multipliers. A discussion of the matrix algebra underlying these concepts is given in Miller and Blair (1985). From a policy perspective, the magnitude of the multipliers are a critical output of an input–output model. The larger the relative size of the

TABLE 4. IMPLAN output: total and direct IMPLAN employment effects at Glen Canyon Dam for water-based recreation activities for selected industries

Sectors	Total number of regional jobs	Direct employment effect	Total employment effect
Maintenance and repair	1456	0·00	7·35
Hospitals	2256	0·00	7·60
Automobile dealer	2668	2·37	9·08
Auto rental	222	9·34	9·72
Food stores	2757	3·48	9·85
Real estate	3316	0·00	10·72
General merchandise	2168	5·87	12·31
Miscellaneous retail	2518	4·63	13·52
Hotels and lodging	5733	41·39	45·27
Restaurants and bars	7052	56·64	56·65
Amusement and recreation	1343	263·04	264·21
Grand total for 528 industries	84 392	448·56	585·71

multiplier for a sector, the greater the economic stimulus from concentrating expenditures in the sector. If the goal of policy is to stimulate real output (employment), government expenditures should be concentrated in the sector with the largest output (employment) multiplier. For the current model, the Type I amusement and recreation sector output multiplier is 1·1581 while the Type III output multiplier is 1·5539. This means that for every dollar of direct demand, there are 0·1581 dollars of indirect demand, and 0·5539 dollars of induced and indirect demand (Taylor *et al.*, 1992). If the goal is to stimulate employment, additional government expenditures should be concentrated in the sector with the highest employment multipliers. That is, the sector with the highest output multipliers will not necessarily be the sector with the highest employment multiplier.

6. The IMPLAN output

Some of the employment estimates for Colorado River recreation expenditures at Lee's Ferry are presented in Table 4. The total number of regional jobs for each of several selected industries is presented along with the total number of jobs provided by Glen Canyon Dam recreation expenditures. The total number of jobs is the sum of a direct, indirect, and induced effect. The direct employment effect of recreation trip expenditures at Glen Canyon Dam is negligible for the automobile service, general merchandise, hospital, real estate, and general maintenance and repair sectors. But the indirect plus induced effects are sizeable for these industries.

The accuracy of the jobs estimates needs to be explored with empirical data. Despite careful perusal by HBRS of the recreationist's expenditure profiles in order to determine the impact zone expenditures, empirical information on the geographic distribution of expenditures would be quite helpful in producing jobs estimates. Much of the interest in the multipliers for the regional model lies in the fact that the multipliers do not vary with the aggregate economic impact zone expenditure vector. The employment estimates

TABLE 5. IMPLAN multipliers for key sectors

Sectors	Induced output Type III	Total output Type III	Total employment Type III
Maintenance and repair	0·1066	1·3735	1·2814
Hospitals	0·2304	1·5074	1·4646
Automobile dealer	0·3309	1·4616	1·2873
Auto rental	0·2599	1·4288	1·3506
Food stores	0·1397	1·5063	1·2841
Real estate	0·1453	1·3093	1·5025
General merchandise	0·5117	1·6347	1·2530
Miscellaneous retail	0·5910	1·7296	1·2517
Hotels and lodging	0·2359	1·6784	1·3131
Restaurants and bars	0·1142	1·8398	1·2341
Amusement and recreation	0·3958	1·5539	1·2916

are a linear function of the employment multipliers, and in certain extreme cases, the multipliers for the regional economy preclude the likelihood or even the possibility of serious errors in jobs estimates. If the aggregate expenditure total for the economic impact zone was known with certainty, and the total employment Type III multipliers were identical, then the aggregate total jobs estimates would be perfectly accurate. The jobs estimates for the individual sectors of the impact zone might have sizeable errors, but the jobs total in this extreme case would be correct.

In early IMPLAN runs of the Coconino–Mojave county model, we made the following error. All of the expenditures in the following categories were incorrectly allocated to retail sector final demand: (1) gas and oil, (2) grocery, (3) personal gear, (4) fishing licenses, and (5) "other". The mistake is one of imputing all of the expenditures in a grocery store to the services provided by the store such as floor space, parking, lighting, heating, and clerking and stocking services. However, most of the dollars spent at a grocery store are primarily for the purchase of inputs purchased by the store and resold to final consumers (e.g. meat, cheese, eggs, poultry, and vegetables). The "other" category includes miscellaneous retail expenditures, and these also involve the use of retail facilities to sell goods that are not manufactured by the retail enterprise. However, lodging and restaurant expenditures are pure retail sectors, and are not "margined". IMPLAN users can use a built-in module that margins for grocery stores and gas retail outlets under the assumption that the regional expenditure pattern duplicates the national average expenditure pattern for these retail sectors. The margining process for other sectors must rely on the best available empirical information. We thought that the error had introduced an upward bias into the jobs total estimates for the impact zone. This was indeed the case, and the original estimate of 607 total jobs was revised downward to 586 total jobs. This represents a 4% positive error in the correct estimated value. If all of the expenditures for groceries are allocated to the grocery store, then the grocery sector does not import any goods and services from outside the impact zone. The downward bias in total imports tends to induce an overestimate in the jobs total.

Note that the relatively modest variation in the multiplier values presented in Table 5 suggests that the aggregate jobs estimates are more accurate than the sectoral jobs estimates. The jobs per million dollars of expenditure estimates are, in turn, more

TABLE 6. IMPLAN jobs impact estimates versus naive estimates (U.S. Bureau of the Census, 1991, 1992)

	Number of jobs based on 1985 GNP	Number of jobs based on 1990 GNP
Naive total expenditures estimates	669	631
Naive impact zone estimates	316	307
1990 IMPLAN impact zone jobs estimates	**Direct = 449**	**Total = 586**

robust than the sectoral jobs estimates or the aggregate jobs total estimates. Errors in the estimating of the amusement and recreation impact zone expenditure totals from the HBRS survey data are, in our opinion, likely to be small relative to other errors. Because this sector contributes more impact zone jobs than any other, accurate estimates of the amusement and recreation zone expenditures totals enhances the accuracy of the aggregate jobs estimates.

7. Policy implications of the estimates

The IMPLAN jobs estimates can be compared with naive estimates of the jobs impacts of recreation expenditures for trips to Lee's Ferry based on data from Table 4. The grand total for expenditures in the impact region is $11 663 813 in 1985 dollars, and $14 167 847 in 1990 dollars. These numbers can be used to produce naive economic impact zone jobs estimates. Naive economic impact zone estimates of the jobs produced by recreation trip expenditures to the Lee's Ferry region produces job estimates of 316 jobs (1985 GNP) and 307 jobs (1990 GNP). The naive impact zone job estimates in Table 6 are close to one-half of the jobs estimates produced by the refined IMPLAN database and input–output regional model.

Employment levels do not vary significantly with flow regime. Most of the expenditures for trips are generated by various rafting activities. The commercial and private whitewater rafting trips are regulated by permits controlled by the National Park Service; hence, there is a fixed upper limit to the number of such trips (Grand Canyon National Park, 1989). Bishop *et al.* (1987) point out that day-use rafting benefits are not sensitive to flow levels. Therefore, the number of day-use raft trips will not vary with flow. Even sizeable variation in the number of angling trips generates only a modest percentage variation in aggregate expenditures. However, recreation expenditures for trips to the Colorado River at Lee's Ferry produce jobs.

Water resource preservation preserves water quality and environmental amenities. Water development projects, diversionary uses of water, and the use of stream flows for contaminant removal lowers the amenity values of instream flows. IMPLAN can be used to estimate the relative labor intensity of various water-based economic activities within the economic impact zone. The IMPLAN output can be used to make comparisons of the relative labor intensity of the outdoor water-related recreation activities and market-oriented water-based activities. IMPLAN lists the total industry outputs and average number of employees (person years) for each industry in the impact region. The total industry output values and employees for various water-based

TABLE 7. IMPLAN 1990 jobs estimates for various water-based economic activities and the 1990 jobs per million dollars of GNP ratio

Activity	Direct employment	Total employment	Output ($ millions)	Jobs per $ million
Recreation	449	587	14·168	41·34
Ranch cattle	44	48	2·419	19·8
Range cattle	341	376	16·339	23
Sheep	117	128	5·589	22·9
Hay-pasture	8	8	0·327	25·6
Fruits	11	13	0·612	20·8
Vegetable	36	52	4·247	12·2
Greenhouse	260	322	12·835	25·1
1990 GNP	—	—	—	21·6

agricultural and agribusiness activities are given in Table 7. The direct employment effect for the recreation expenditures at Lee's Ferry and the average number of employees in each industry are listed in the first column of Table 7. The direct effect for recreation represents the number of people employed in the hypothetical industry created by impact region recreation expenditures. The total job effects listed in Table 7 incorporates appropriately scaled indirect and induced effects[1]. These direct and induced effects were estimated from IMPLAN estimates of the employment effect of an additional one million dollars of impact zone total industry final demand for the industry in question. Note also that the detailed information made available in IMPLAN about the actual total industry output and employment include value-added and final demand estimates for all of the sectors in the impact zone. However, the category listed in the final column of Table 7 is total industry output, which corresponds most closely to total sectoral expenditures. But jobs per dollars of value added is also a useful measure because it quantifies the economic activity within the economic impact zone. Gross impact zone expenditures do not net out imports. Imports do not contribute as much as productive activities do to streamflow contaminant loadings within the impact zone.

The bottom row in Table 7 shows the number of jobs produced by a million dollars of GNP in 1990. The outdoor recreation activities at Lee's Ferry produce nearly twice as many jobs per million dollars of expenditure as the national economy. Note also that while the multipliers are structural features of the model economy, the IMPLAN output can be used to estimate a Type III employment multiplier for impact zone expenditures. Let m_e be the pertinent multiplier; $m_e = (585{\cdot}71)/448{\cdot}56 = 1{\cdot}306$. For every job produced directly by recreation expenditures at Lee's Ferry, there are 0·306 jobs produced by indirect or induced effects. Table 7 demonstrates that outdoor recreation activities at Lee's Ferry are labor intensive.

Note also that the job estimates for water-based activities listed here underestimate the economic significance of Colorado River recreational expenditures for the stream reach between Lake Powell and Lake Mead. The estimates of the fraction of trip expenditures that occur in the economic impact zone are conservative. Also, federal regulations restrict fishing to the portion of river within the Glen Canyon National Recreation Area. Thus, angling is confined to the reach that lies between the Glen Canyon Dam and Lee's Ferry. The National Park Service regulates rafting between

[1] The authors are indebted to G. Alward, S. Winter, and E. Siverts for suggesting this procedure.

Lee's Ferry and Diamond Creek. But whitewater rafting occurs in the reach between Diamond Creek and Lake Mead. The Hualapai Tribe issues permits and supplies guides for trips that originate in this reach, and the impact of rafting expenditures on the tribe is considerable. The commercial and whitewater rafting data given here omit these trips and expenditures. Data supplied by the Hualapai Tribe indicate that in 1991, there were 1504 commercial and 467 private whitewater rafting trips in the reach below Diamond Creek. The average expenditures were $299 for commercial trips and $103 for private trips.

Recreation-based jobs can typically be maintained for a long period of time. Jobs based on logging, mining, or other market-oriented uses of renewable natural resources last for only two or three decades due to myopic management policies (Caufield, 1986). Moreover, instream flow can support recreational activities at several sites. Recreation expenditures generated by water-based activities along upper Colorado River tributaries, at Lake Powell, the Colorado River between Diamond Creek and Lake Mead, and at Lake Mead, can be added to those estimated by the current study in estimating a grand total for the Colorado River nonmarket jobs impact. Diversionary market-oriented water uses typically consume water and (or) generate low quality return flows. This, in turn, implies that jobs for upstream water-related market-oriented activities partially displace downstream water-based jobs.

There are several policy contexts in which IMPLAN output similar to that presented here is useful. For example, in certain western U.S. river basins, regulating irrigation uses, so that irrigators economize on the use of surface water by installing certain types of irrigation systems (e.g. drip versus center pivot irrigation systems for perennial crops) so that nonmarket environmental amenities may be enhanced by improved water quality and increased instream flows, is a major water allocation issue (Reisner, 1988). Because the Colorado River basin is the largest basin in the southwestern U.S., Tables 5, 6, and 7 shed pertinent indirect evidence on this issue. Outlays of money for irrigation equipment that improve stream water quality and thereby increase participation in river-based recreation activities may also increase regional employment opportunities.

References

Baucom, F. (1992). Personal communication. Phoenix, Arizona: Field Office, U.S. Fish and Wildlife Service.

Bergstrom, J. C., Cordell, H. K., Ashley, G. A. and Watson, A. E. (1990). Economic impacts of recreational spending on rural areas: a case study. *Economic Development Quarterly* **4**, 29–39.

Bishop, R. C., Boyle, K. J., Welsh, M. P., Baumgartner, R. M. and Rathbun, P. C. (1987). *Glen Canyon Dam Releases and Downstream Recreation: An Analysis of User Preferences and Economic Values.* (Glen Canyon Environmental Study Report #27/87.) Washington, D.C.: U.S. Bureau of Reclamation [Available from NTIS, as NTIS Report #PB88-183546/AS].

Boyle, K. J. and Bishop, R. C. (1984). *Lower Wisconsin River Recreation: Economic Impacts and Scenic Values.* (Research Report No. 216.) Madison: University of Wisconsin.

Caufield, C. (1986). *In the Rainforest: Report from a Strange, Beautiful, Imperiled World.* Chicago: University of Chicago Press.

Cherry, S. (1993). Personal communication. Grand Canyon, Arizona: Grand Canyon National Park.

Colby, B. G., Crandell, K. B. and Rait, K. A. (1992). Valuing riparian areas: a southwestern case study. *Rivers* **3**, 88–98.

Cordell, H. K., Bergstrom, J. C., Ashley, G. A. and Karish, J. (1990). Economic effects of river recreation on local economies. *Water Resources Bulletin* **26**, 53–60.

Daubert, J. T. and Young, R. A. (1981). Recreational demands for maintaining instream flows: a contingent valuation approach. *American Journal of Agricultural Economics* **63**, 666–676.

Douglas, A. J. (1988). *Annotated Bibliography of Economic Literature on Instream Flows.* (Biological Report 88(39).) Washington, D.C.: U.S. Fish and Wildlife Service.

Grand Canyon National Park (1989). *Colorado River Management Plan.* Grand Canyon, Arizona: U.S. Department of the Interior.

HBRS (1991). Personal communication. Madison, Wisconsin: HBRS. [The Glen Canyon Environmental Studies expenditure data noted by Bishop *et al.* (1987) have been placed on disks that are available on request from HBRS].

Janisch, E. (1985). *Evaluation of the Lee's Ferry Fishery and Future Management*. Phoenix, Arizona: Arizona Game and Fish Department (Report to the Fisheries Branch).

Just, R. E., Hueth, D. L. and Schmitz, A. (1982). *Applied Welfare Economics and Public Policy*. Englewood Cliffs, New Jersey: Prentice-Hall.

Lavender, D. (1985). *River Runners of the Grand Canyon*. Grand Canyon, Arizona: National History Association.

Loomis, J. B., Wegge, W. M. and Hanneman, W. M. (1990). *Environmental Benefits Study of San Joaquin Valley's Fish and Wildlife Resources*. Sacramento, California: Jones and Stokes Associates.

Miller, R. E. and Blair, P. D. (1985). *Input–Output Analysis: Foundations and Extensions*. Englewood Cliffs, New Jersey: Prentice-Hall.

Olsen, D., Richards, J. and Scott, R. D. (1991). Existence and sport values for doubling the size of Columbia River Basin salmon and steelhead runs. *Rivers* **2**, 44–56.

Reisner, M. (1988). The next water war: cities versus agriculture. *Issues in Science and Technology* **5**, 98–102.

Richards, M. T. and Wood, D. B. (1985). The economic value of sportfishing at Lee's Ferry, Arizona. In: *Riparian Ecosystems and their Management: Reconciling Conflicting Uses* (R. R. Johnson, C. D. Ziebell, D. R. Patton, P. F. Ffolliott, and H. R. Hamre, eds), pp. 219–222 (General Technical Report RM-120). Washington, D.C.: U.S. Forest Service, pp. 219–222.

Riley, L. (1993). Personal communication. Phoenix, Arizona: Arizona Department of Game and Fish.

Ritenour, J. P. (1993). Personal communication. Chief, Resources Division, Page, Arizona: Glen Canyon National Recreation Area.

Taylor, C., Winter, S., Alward, G. and Siverts, E. (1992). *Micro Implan User's Guide*. Fort Collins, Colorado: U.S. Forest Service.

U.S. Bureau of the Census (1991). *Statistical Abstract of the United States: 1991*. (111th edition). Washington, D.C.: U.S. Department of Commerce.

U.S. Bureau of the Census (1992). *Statistical Abstract of the United States: 1992*. (112th edition). Washington, D.C.: U.S. Department of Commerce.

Walsh, R. G. (1980). *Empirical Application of a Model for Estimating the Recreation Value of Water in Reservoirs Compared to Instream Flow*. (Completion Report No. 103). Fort Collins, Colorado: Colorado Water Resources, Institute, Colorado State University.

Wilderness River Adventures (n.d.). *Experiencing a Scenic Glen Canyon–Colorado Float Trip*. Page, Arizona: Wilderness River Adventures.