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Introduction

Frequently economists and regional planners desire information on congestion costs at fixed-capacity facilities such as developed recreation sites, museums, or urban parks. Estimates of congestion costs enable researchers to: (1) more accurately select the user fee required to ration the use of the facility to the desired level (Walters 1961, Oakland 1972, Haveman 1973, Rothenberg 1970, and Fisher and Krutilla 1972), and (2) more completely account for the positive or negative externalities associated with a recreational site development, expansion, or contraction (Squire and van der Tak 1975, Dasgupta and Pearce 1978, and Freeman 1977). Traditionally, multiple regression approaches with a proxy variable for congestion (such as users per acre or encounters per day) have been adopted to measure congestion costs (*e.g.*, Cicchetti and Smith 1973, Deyak and Smith 1978, and McConnell 1977). The purpose of this research is to introduce a methodology for estimating these external costs when an acceptable proxy for congestion is not available (*e.g.*, when congestion is a function of the types and locations of users as well as the total number of participants). The following section presents a theoretical review of quality-adjusted demand curves. Next the indexation methodology employed in this application is discussed, followed by an empirical illustration of its use for a popular urban lake in Arizona. It is concluded that the indexation technique for estimating congestion costs has several advantages in a variety of empirical applications.

User-Fees and Quality-Adjusted Demand Curves

Rationing a fixed-capacity resource by imposing a user fee is complicated in application by the difficulty of estimating a quality-adjusted demand curve. As the level of facility use declines, congestion costs decline, causing the willingness-to-pay of facility users to rise. The benefit of enhancing the quality of the experience to users as participation levels and congestion costs decline must be reflected in the estimated demand curve or user fees will be systematically underestimated.

The estimation problem is illustrated in Figure 1. As the number of facility users increases, additional congestion costs are incurred. For a relatively homogeneous group of users, this can be illustrated by willingness-to-pay schedules falling with level of facility use, $WTP_1 \ldots WTP_N$ (Fisher and Krutilla).[1] Notice that none of these individual willingness-to-pay schedules constitutes a demand function for the facility since only one point on each schedule will be observed. The quality-adjusted demand curve is generated by varying the participation price and computing the resulting number of facility users (Freeman and Haveman). For example, when an admission fee of F_1 is charged, Q_1 individuals will participate, since only that number of users have a willingness to pay in excess of F_1 when the level of facility use is Q_1. Thus, point "a" lies on the quality-adjusted demand curve (D). Repeating this process, a series of points lying on this curve can be identified.

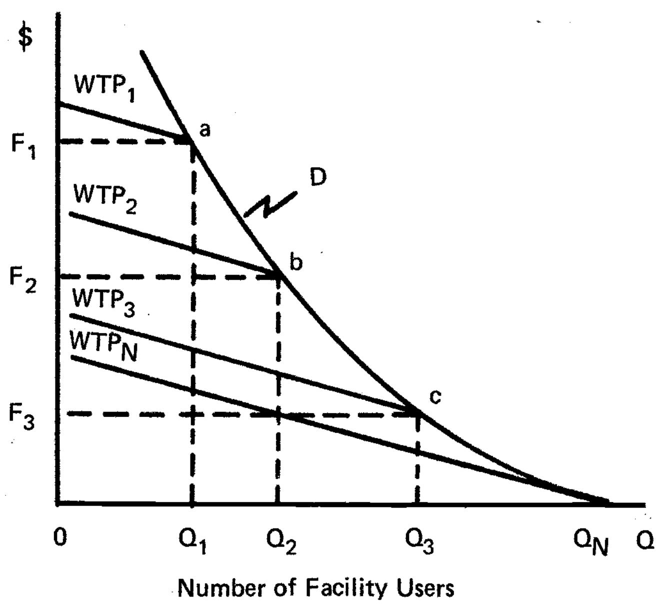

Figure 1. Derivation of a Quality-Adjusted Demand Curve

The unrestricted level of use occurs at Q_n where the uncongested willingness-to-pay of the marginal user equals the average congestion cost and no fee is charged. Typically, the resource manager has information about WTP_N, the willingness-to-pay of facility users at the unrestricted level of use. Imposing a fee based on this information in an attempt to lower facility use to a prespecified level will result in a supraoptimal number of users participating.[2] For example, if the level of use were to be limited to Q_2, WTP_N would indicate that a fee of F_3 would be sufficient when in fact a fee of F_2 is required. The difference between these two fees reflects the quality improvement associated with the reduction in average congestion costs experienced by the users when the level of use is reduced from Q_N to Q_2.

The implementation problem facing the use of fees to ration the use of a fixed-capacity facility subject to congestion costs arises directly out of the difficulty of estimating how congestion costs will be reduced as participation rates decline. In particular, an estimate for the change in average congestion cost is needed so that a quality-adjusted demand curve can be estimated from the readily available schedule of unrestricted willingness-to-pay.

A linear approximation of the quality-adjusted demand curve is illustrated in Figure 2. Having estimated the change in average congestion cost (α) associated with participation being reduced from a "congested" level of Q_c to an "uncongested" level of Q_u, point "a" on the quality-adjusted demand curve (D) can be identified using the known WTP_c. Connecting "a" and Q_c yields the linear approximation D. The indexation methodology discussed in the next section provides an attractive alternative procedure to multiple regression techniques for estimating congestion costs at various levels of facility use.

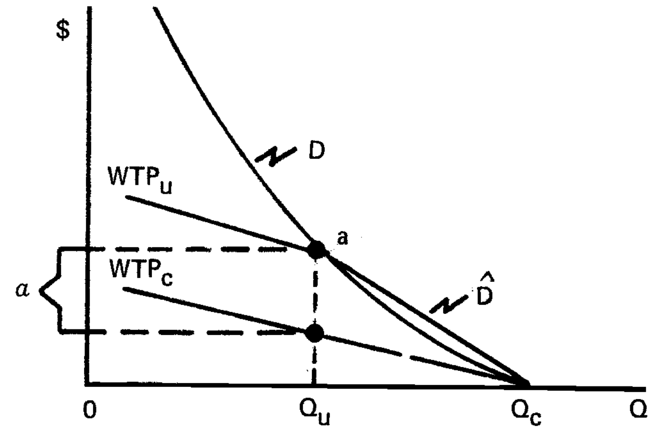

Figure 2. Linear Approximation of a Quality-Adjusted Demand Curve

Indexation

According to Eichhorn (Eichhorn, *et al.* 1978, p.3),

> An *economic index* is an economic measure, *i.e.,* a function F: DIR which maps, on the one hand, a set D of economically interesting objects into the set IR of real numbers and which satisfies, on the other hand, a system of economically relevant conditions (for instance, monotonicity and homogeneity or homotheticity conditions).

Economic indices were initially devised in 1764 by G. R. Carti to measure the effect of the discovery of America upon the purchasing power of money in Europe (Mitchell 1938). While the sophistication of index number theory has increased greatly since Carti (refer to Afrait 1977; Allen 1975; Banerjee 1977; Eichorn, *et al.,* 1978; Fisher and Shell 1972; Mitchell 1938; and Mudgett 1951), the estimation of general price level fluctuations *(e.g.,* Consumer Price Index, Wholesale Price Index, and GNP Deflator) continues to be the most visible use of indexation. However, indexation techniques have been adopted by regional scientists and labor economists to measure such diverse phenomena as changes in industrial composition and production, inequality of incomes, and fluctuations in employment and unemployment (Allen 1975, Douglas 1967, and Isard 1960).

Two studies are of particular interest with respect to the utilization of indexation to measure congestion costs. In a 1961 National Bureau of Economic Research study, Borts developed hypothetical employment indices to measure the variations in manufacturuing employment that regions of the United States would experience (regional business cycles) if fluctuations within the regions' manufacturing groups were identical to those experienced by the same industries for the nation. That is, indexation was used to estimate the portion of regional business cycles attributable to the industrial composition of the area (hypothetical business cycles). The differences between the hypothetical and actual business cycles were attributed by Borts to differences in behavior between national and regional industries. Gwartney, in a 1970 *American Economic Review* article, adopted the indexation technique to isolate that portion of the white-nonwhite income differential which could be explained by white-nonwhite differences in age, sex, education, training, and geographic location. The white-nonwhite income differential that remained after accounting for the above productivity factors through indexation (the residual) was attributed to discrimination. In this paper, the indexation methodology applied by Borts and Gwartney (the residual technique) is applied to the problem of measuring congestion costs at a recreational facility when an adequate proxy for congestion is not available. That is, the characteristics of recreation site users during a congested period will be "mapped" onto the willingness-to-pay function of users during the uncongested period. The willingness-to-pay differential between the congested-period and the uncongested-period users that remains after the characteristics have been mapped represents an estimate of the impact of congestion costs on the patrons' willingness to pay.

Indexation Measures of Congestion Costs

Consider two groups of facility users, one subject to high congestion costs (say weekend users) and the other subject to comparatively low congestion costs (say weekday users). Other things equal, the average willingess-to-pay (WTP) of the congested group would be expected to be less than the average willingness-to-pay of the users in the less congested group. But other things are not constant. A differential in willingness-to-pay between the two groups may arise as the result of distributional differences in several factors other than congestion costs. Differences in income levels, frequency of use, and distance from site are just a few examples of variations between the two groups that could partially explain willingness-to-pay differentials. Indexation is a technique that may be used to estimate the impact of these noncongestion factors on the ratio of the average willingness to pay of the two groups. That is, this procedure breaks down the willingness-to-pay differential between the two groups into two categories: (1) a difference resulting from factors influencing willingness-to-pay other than congestion costs (noncongestion factors), and (2) a residual unaccounted for by differences in noncongestion factors which may result largely from congestion.

Three indices (unadjusted, Laspeyres, and Paasche) are used to isolate the impact of noncongestion characteristic j on the ratio of the average WTP of the two groups.[3]

Unadjusted:
$$\frac{\bar{W}_u}{\bar{W}_c} = \frac{\Sigma_i W_u^i D_u^i}{\Sigma_i W_c^i D_c^i}$$

Laspeyres:
$$L_j = \frac{\Sigma_i W_u^i D_c^i}{\Sigma_i W_c^i D_c^i}$$

Paasche:
$$P_j = \frac{\Sigma_i W_u^i D_u^i}{\Sigma_i W_c^i D_u^i}$$

where:

L_j = Laspeyres Index

P_j = Paasche Index

$\bar{W}_c$ = the average willingness to pay of individuals in the congested group or time period,

$\bar{W}_u$ = the average willingness to pay of individuals in the uncongested group,

i = distributional category of willingness to pay characteristic j (e.g. income classes or participation levels),

W_c^i = the average willingness to pay of individuals in the congested group of users who are within category i,

W_u^i = the average willingness to pay of individuals in the uncongested group of users who are within category i,

D_c^i = the percent of the congested group of users within category i,

D_u^i = the percent of the uncongested group of users within category i.

The unadjusted index is simply the ratio of the average willingness to pay of individuals in the uncongested time period to the average willingness to pay of those who visited during the congested period. The Paasche index of willingness-to-pay differences is the hypothetical ratio of the mean willingness-to-pay of slack-time to peak-time facility users, assuming both groups were distributed among the noncongestion characteristic j as the slack-time users actually were. In contrast, the Laspeyres index of willingness-to-pay differences is the hypothetical ratio of the mean WTP under the assumption that both groups of users had the distribution of the noncongestion characteristic j associated with the peak-time group. Thus, the Paasche index maps the characteristics of the uncongested periods' users into the WTP function of the congested periods' participants and alternatively the Laspeyres index is a mapping of the congested periods' users characteristics into the WTP function of the uncongested periods' patrons. The Laspeyres and Paasche indexes bound the "true" measure of the impact of noncongestion characteristic j on participants' mean WTP (Afriat 1977, p. 39).[4]

Comparisons of the unadjusted ratio with Laspeyres and Paasche indices provide estimates of the importance of factors other than congestion costs on individuals' willingness to pay. For example, assume the income distributions and willingness-to-pay of weekend and weekday visitors are as presented in Table 1.

Table 1
Hypothetical Willingness-to-pay Data for Visitors to a Recreational Facility

Income Classes	Weekday (Uncongested) WTP (W_u^i)	Weekday (Uncongested) % Within Income Class (D_u^i)	Weekend (Congested) WTP (W_c^i)	Weekend (Congested) % Within Income Class (D_c^i)
$ 50,000+	$7	10%	$6	5%
40-49,999	6	20	5	10
30-39,999	5	40	4	15
20-29,999	4	15	3	40
10-19,999	3	10	2	20
0- 9,999	2	5	1	10

The unadjusted, Laspeyres, and Paasche indices would be computed as follows.

$$\text{Unadjusted Ratio} = \frac{.1(7) + .2(6) + .4(5) + .15(4) + .1(3) + .05(2)}{.05(6) + .1(5) + .15(4) + .4(3) + .2(2) + .1(1)}$$

$$= \frac{4.90}{3.10} = 1.58$$

$$\text{Laspeyres Index} = \frac{.05(7) + .1(6) + .15(5) + .4(4) + .2(3) + .1(2)}{.05(6) + .1(5) + .15(4) + .4(3) + .2(2) + .1(1)}$$

$$= \frac{4.10}{3.10} = 1.32$$

$$\text{Paasche Index} = \frac{.1(7) + .2(6) + .4(5) + .15(4) + .1(3) + .05(2)}{.1(6) + .2(5) + .4(4) + .15(3) + .1(2) + .05(1)}$$

$$= \frac{4.90}{3.90} = 1.26$$

The unadjusted ratio indicates that the WTP of weekday visitors is on the average 58% greater than the WTP of the congested group (weekenders). However, according to the Laspeyres and Paasche indices, the WTP of weekday visitors would only be 26 to 32% greater than the WTP of the congested group if the two groups had a similar distribution of income. If income is the only noncongestion characteristic for which the weekend and weekday visitors significantly differ, the unexplained residuals in the Laspeyres and Paasche indices (.32 and .26 respectively) can be attributed to congestion costs. If the noncongestion characteristic (income) completely explained the WTP differences between weekend and weekday visitors, the Laspeyres and Paasche indices would equal 1.00.

In summary, the Laspeyres and Paasche indices provide an estimate of the ratio of uncongested to congested willingness to pay after adjusting for differences in noncongestion characteristics. Having accounted for other factors which affect the differential in average willingness to pay between the two groups, the residual difference becomes an estimate for the difference in average congestion cost at the two levels of facility use.[5]

An Empirical Application

Personal interviews were conducted at Chaparral Lake (Scottsdale, Arizona) each week for a one-year period (Martin, Garifo, and Gum). Two weekdays and one day of the weekend were randomly selected each week to conduct interviews. A total of 471 adult users were interviewed over this period, constituting 12% of the total number of adult permits issued. The questionnaire consisted of 29 items including willingness to pay for a six-month fishing permit, distance traveled to site, income and various demographic variables. In addition, the total level of use (*i.e.,* the total number of permittees participating) was tabulated for each interview day.[6]

The interview data acquired was then partitioned so that unemployed or retired individuals, persons not fishing for trout, and individuals fishing at night, on holidays, or during inclement weather were omitted from the sample.[7] For the remaining individuals in the sample, the participation levels were approximately 2.4 times higher during weekends than during weekdays.[8] Furthermore, the mean willingness to pay for a six-month permit of the weekday visitors was $8.07 while that of the weekend group was $6.79. This amounts to an unadjusted ratio of mean willingness to pay for the two groups of 1.189, indicating that users on the less congested weekdays were willing to pay 18.9% more, on average, for the fishing experience than users during the more congested weekend days. To isolate what portion of this WTP differential is attributable to differences in congestion costs, indexation was adopted.

In selecting variables to be used in indexing, three criteria were employed. First, only factors generally recognized as determinants of recreation demand or as being closely correlated with willingness-to-pay, were selected. Second, the indexed factors are not directly related to congestion costs as such. Finally, a Chi-squared test of significance is utilized to determine if the distributions (weekend versus weekday) of the noncongestion factors are significantly different. Only variables with significantly different distributions need be considered. Using these three criteria, the following characteristics were selected: income, occupation, visits per season, distance from residence to lake, age, and total catch on the day interviewed.[9]

Income-Occupation Adjustment. Income levels ranged from $5,000 to $25,000 per year for the weekday and weekend users interviewed. Weekend respondents had slightly higher average incomes ($12,837) than weekday respondents ($12,291). The occupations of interviewed users were exhaustively classified into five categories: professional and technical, managerial, clerical and sales, production, and service. For indexation, income and occupation differences between the two groups of users were treated simultaneously since the two factors are correlated. In particular, the income range of the users was divided into four groups by $5,000 increments. Combining this classification with the five categories for occupation resulted in a 20 cell income-occupation distribution for lake users.

Imposing the lower income distribution of the weekday users on the weekend group resulted in an adjusted Paasche index of mean willingness-to-pay of 103.2 (see Table 2). Imposing the higher income distribution of the weekend users on the weekday group resulted in an adjusted Laspeyres index of 116.2. This amounts to marginal effects of -15.3 and -2.3 for the Paasche and Laspeyres indices respectively, compared to the unadjusted ratio of mean willingness-to-pay for the two groups of 118.7. That is, if the two groups of users had an identical distribution among income-occupation cells, the weekday users would still be willing to pay, on the average, 3.2 to 16.2 percent more for the fishing experience.[10]

Adjustments for Visits per Season, Distance to Site, Size of Catch, and Age of Permittees. The weekend users on the average were younger, had less accessibility to the lake, exhibited a higher rate of participation (visits per season), and experienced greater fishing success than the weekday participants. Imposing the age, accessibility, participation, and catch-size distributions of the weekend users on the weekday group (Laspeyres) resulted in marginal changes of 7.8, -22.9, 3.0, and 20.0 respectively. Adjusting for these four characteristics results in a total marginal change in the Laspeyres Index of 7.9, indicating that a weekday group with the same age, accessibility, participation, and success distributions as the weekend users would be willing to pay 7.9% more for fishing permits. Alternatively, giving the weekend group the weekday users' age, accessibility, participation, and success distributions (Paasche) resulted in marginal changes of 2.0, -19.9, 18.6, and 2.5 respectively, or a cumulative effect of 3.2%. That is, weekend users would be willing to pay only 3.2% more for the permits if the distributions of the nonincome factors were similar to those characteristic of weekday participants.

In summary, the two groups of users have been made comparable with respect to employment status, type of fish caught, high fishing success periods, and daytime use by selecting interviews conducted under these conditions. The fishing experience is comparable with respect to these factors. In addition, six other factors which affect the mean willingness-to-pay differential between the two groups were evaluated through indexation. Giving the congested and uncongested groups the same distributions across income/occupation, number of visits per season, distance to site, size of catch, and permittee age categories, results in an adjusted mean willingness to pay for the uncongested group between 6.4 and 24.1 percent higher than that of the congested group.[11]

As noted earlier, the congestion cost estimates provided by the Paasche and Laspeyres indices bound the "true" measure of congestion. Once the bounds have been computed, a point estimate of average congestion cost can be derived with the Fisher Ideal Index.

Fisher Ideal Index = (Laspeyres Index X Paasche Index)$^{1/2}$

Since the Fisher Index is the geometric mean of the Laspeyres and Paasche indices, this estimate will be less affected by extremely large or small values than would an arithmetic mean. For the urban fishing lake, the Fisher Index is 114.9. That is, a residual difference of 14.9% remains unexplained, a residual attributed to the change in average congestion costs between the groups.

Adjusting User Fees for Changes in Congestion Costs at Chaparral Lake

The elasticity of weekend users' average willingness-to-pay with respect to level of facility use (ϵ_{WQ}) is assumed to be constant over use levels under consideration. The

Table 2

Willingness to Pay of Weekday Users as a Percentage of Weekend Users, Adjusted for Various Determinants of Willingness-to-pay Differentials between Weekday and Weekend Users of Chaparral Lake in 1977-78.

Index of WTP Differences	Marginal Effect of Factor		Cumulative Index of Differences			
	Laspeyres	Paasche	Laspeyres	Paasche	Laspeyres	Paasche
Unadjusted WTP Ratio (Weekday/Weekend)	118.9	118.9	—	—	—	—
Explanatory Factors						
A. Income-Occupation	116.2	103.2	- 2.3	-15.3	116.2	103.2
B. Number of Visits	121.9	137.5	3.0	18.6	119.2	121.8
C. Distance of Site	96.0	99.0	-22.9	-19.9	96.3	101.9
D. Size of Catch	138.9	121.4	20.0	2.5	116.3	104.4
E. Permittee Age	126.7	120.9	7.8	2.0	124.1	106.4

Fisher Index = $[(124.1)(106.4)]^{1/2} = 114.9$

results of the empirical study of congestion costs at Chaparral Lake indicate that the average willingness-to-pay of weekend users ($\bar{w}$) increases by 14.9% when the level of facility use (Q) changes from the seasonal average for weekend use (52 anglers) to the seasonal average for weekday use (22 anglers). Reducing weekend use to the average weekday use would amount to a reduction of 57.7% in the level of weekend facility use. The estimated $\epsilon_{\bar{w}Q}$, then, is:

$$\epsilon_{\bar{w}Q} = \%\Delta\bar{W}/\%\Delta Q$$

$$= 14.9\%/57.7\%$$

$$= 0.258$$

The fee adjustment required to account for the quality improvement accompanying a less congested fishing experience (α) is simply the estimated change in average congestion cost ($\Delta\bar{W}$) associated with reduced use levels. That is,

$$\alpha = \alpha(Q)$$

$$= \bar{W}_0(\epsilon_{\bar{w}Q})(\%\Delta Q)$$

where $\bar{w}_0$ is the average willingness to pay of weekend users at unrestricted levels of use. Substituting estimated values for Chaparral Lake gives:

$$\alpha = \$8.07(0.258)(\%\Delta Q).$$

The $\%\Delta w$ and α for various levels of weekend use below the unrestricted level of 52 permittees are presented in Table 3. If the weekend level of use were to be reduced to the average weekday level of use by imposing user fees, a 57.7% reduction in the number of anglers would result, with an accompanying 14.9% increase in the weekend users' average willingness-to-pay. To reach this lower level of use, the user fee would have to be increased an additional $1.24 to reflect the change in average congestion cost experienced by the users. A less dramatic reduction would be to lower the weekend level of use to 42 anglers, a 19.2% reduction in use level. The associated 5.1% increase in the weekend users' average willingness to pay resulting from this change would require a $0.41 increase in the user fee above that indicated by the unrestricted willingness-to-pay schedule.

Finally, the quality-adjusted demand curve is estimated by adding the fee adjustment schedule to the estimated unrestricted willingness-to-pay function for weekend users.

Table 3
Adjusting User Fees for Changes in Congestion Costs

Administratively Selected Level of Use	Percentage Reduction In Use Levels ($\%\Delta Q$)	Percentage Increase in Average Willingness to Pay ($\%\Delta\bar{W}$)	Fee Adjustment($)
22	57.7	14.9	1.24
32	38.5	10.2	0.82
37	28.8	7.6	0.62
42	19.2	5.1	0.41
52	0	0	0

Conclusion

The Laspeyres and Paasche indexation method will be a desirable alternative methodology for measuring congestion costs when: (1) an encounter simulation approach is too expensive to adopt, and (2) congestion costs are a function of the quantity, quality, and location of the facility's visitors, with the result that oversimplified proxy variables such as users per acre may not accurately estimate congestion. However, in using indexation techniques, care must be exercised in accounting for all relevant determinants of willingness-to-pay other than congestion costs. Omission of key factors can bias the residual estimate for the change in average congestion costs. Accordingly, information on a variety of factors influencing willingness-to-pay levels must be collected from those users interviewed. Careful attention to interviewing users with similar recreation experiences can greatly reduce the number of factors that must be accounted for through indexation. Finally, it should also be noted that the indexation approach to measuring congestion costs requires a less congested comparison group, such as weekend *versus* weekday or summer *versus* winter. Thus, facilities constantly subject to high congestion costs cannot be evaluated with this technique.

The phenomenal growth in demand for outdoor recreation in the United States is well documented (Fisher and Krutilla). Assessing the impact of congestion on consumer welfare in recreation facilities can realistically be expected to become increasingly important. Laspeyres and Paasche indices of willingness-to-pay are versatile evaluation tools for this purpose.

Endnotes

1. Throughout this analysis it is assumed that tastes for congestion avoidance are homogeneous. That is, $c_j(Q) = C(Q)/Q$, for all j, any Q, where C(Q) is total congestion cost and $c_j(Q)$ is the congestion cost experienced by individual j when the total number of facility users is Q. For a discussion of the ramifications of heterogeneous tastes for congestion avoidance on optimal admission fees see Freeman and Haveman.
2. "Optimal" admission fees in this context are efficient in a second-best sense. Unless the administratively selected level of use is the level which maximizes net benefits of facility use, optimality in the first-best sense will not be attained. For a discussion of equity-efficiency tradeoffs relevant to selecting a target level of use see Cory.
3. For the derivation of the Paasche and Laspeyres indices refer to Eichhorn, *et al.* (1978, pp. 197-300) or Allen (1975, pp. 178-180).
4. The Paasche index will be greater than the Laspeyres if price (WTP in this case) and quantities tend to move in the same direction between years 0 and 1; the Laspeyres index is the greater if prices (WTP) and quantities tend to go in opposite directions (Allen 1975, p. 64).
5. Interested individuals may refer to Banerjee (1977, p. 35-51) for a more complete discussion of indices for more than two factors.
6. Willingness-to-pay questions were asked for the fishing experience as is, one for which creel limits were doubled, and a no stocking fishing environment. Both direct response and bidding game answers were solicited. The results of willingness-to-pay estimations, as well as estimates of net program benefits, are reported in Martin, Garifo, and Gum.
7. Out of the 471 interviewed participants, only 98 purchased a fishing license for two or more consecutive seasons. These 98 interviews were selected for consideration so that only fishermen with well-formed preferences and attitudes concerning the use of the lake would be considered. In an effort to keep the empirical section brief, the sample was reduced further (to 50 fishermen) by considering only employed daytime fishermen who participated on non-holidays. Thus, the number of characteristics to be controlled for by indexation was reduced and, hopefully, the clarity of the technicque enhanced. The reader should note that the empirical results presented in the paper are used only to illustrate the indexation approach to measuring congestion costs. The specific estimates given for Chapparal Lake have no inherent significance to practitioners using the indexing technique. In other applications, researchers would certainly be free to make alternative stratification decisions as experience and context would dictate.
8. The lake was stocked every two weeks with higher success fishing lasting for one week. The average fishing success of the anglers was 0.29 and 0.26 trout per hour for the high success weekday and weekend users respectively, with no significant difference between the means at the 5 percent confidence level. Daytime fishing was defined as fishing between 6:00 a.m. and 6:00 p.m. A total of 49 interviews were taken under the conditions discussed above.
9. The empirical findings of Martin, Garifo, and Gum, as well as a large body of previous research on recreation demand, indicated the importance of these factors in determining willingness-to-pay. Income is the single factor that may have violated the second criterion. Freeman and Haveman discuss the theoretical implications of income and congestion costs being correlated. However, since no clear-cut empirical evidence exists in this regard, the assumption of homogeneous tastes for congestion avoidance was adopted.
10. The downward adjustment of the unadjusted ratio after controlling for income-occupation differences is consistent with the empirical finding of Martin, Garifo, and Gum that urban fishing at Chaparral Lake is an inferior good.
11. The difference between the Laspeyres and Paasche in the above example (6.4 percent to 24.1 percent) resulted from the application of the indexation technique to a small sample (50 fishermen). Increasing the number of observations reduces the differential between the upper and lower bounds.

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