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VALUE COMPARISONS IN FREE-FLOWING STREAM DEVELOPMENT†

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The use of benefit-cost analysis has greatly facilitated the formulation and selection of water resource development projects. One continuing point of confusion and conflict is that surrounding the evaluation of recreation associated with a free-flowing stream and that yielded by a development project. Such outputs as hydropower, navigation, and flood control aside, a significant question often centers on the relative worth of the recreation and related values associated with the alternatives of no development and projects which alter the characteristics of a river. Wild river debates exemplify this.

The intent here is to attempt to clarify some of the issues surrounding the evaluation of recreation benefits associated with uses of a proposed project and to suggest ways in which current procedures may seriously misstate the economic worth of the alternatives. While the alternatives often involve development and non-development of a stream, similar questions of evaluation also occur in comparisons among various reservoir projects. This concern with the values associated with recreational use of the resources does not imply that there may not be significant non-user values as well, such as, maintaining an option to use certain resources for a given purpose sometime in the future.[1]

The particular concern is with the relationship of the values ascribed to alternative resource uses and the range of meaningful substitutes that are available for each of those uses. Simply stated, those resource commitments that have ready and plentiful substitutes have less value, all other things remaining equal, than those which are more rare. A reservoir in a region without lakes is generally to be prized more dearly than another in the midst of many, and so with streams in canyons, or ones with great and rare scenic qualities.

It is not currently feasible to ascribe a precise value to every alternative use of a stream. However, some useful principles can be

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1. Weisbrod, *Collective-Consumption Services of Individual-Consumption Goods,* 78 Q.J. of Econ. 471-77 (1964); and Krutilla, *Conservation Reconsidered,* 57 Am. Econ. Rev. 777-86 (1967).

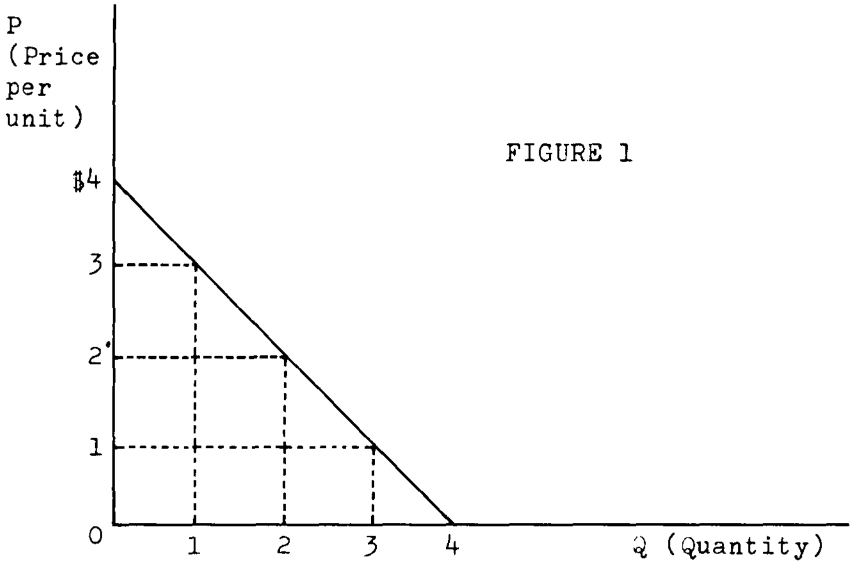
applied to the question of relative values. Current procedures, and especially the official guides, often neglect or run counter to these.

RESOURCE VALUES AND BENEFITS

The primary objective of evaluating the recreation output of alternative resource development proposals is the maximization of economic welfare. The operational definition of this criterion is that the benefits from the alternatives are valued in terms of individual users' willingness-to-pay for the use of the resource rather than go without the services afforded by the resources. This willingness-to-pay measures what people are willing to sacrifice or give up to obtain the good or service and thereby measures its relative value. For most goods and services, market prices give reasonably good measures of these values. For others, including most values associated with environmental quality and outdoor recreation, the price system does not yield such convenient guides, although the nature of economic value and the implications of the willingness-to-pay are equally applicable. It is this willingness-to-pay, rather than what people are required to pay, that is the measure of benefits received in these cases.

The measurement of values appearing as benefits in benefit-cost analysis are conceptually consistent with prices of market commodities. In a market economy, resources are allocated to uses for which users are willing to pay a price which bids them away from alternative uses; and those uses for which the willingness-to-pay is insufficient to bid away the resources will not be undertaken. Comparable to the role of price as an objective rationing device insuring that goods and services end up in uses for which willingness-to-pay is the greatest, the criterion of an implied willingness-to-pay is equally applicable for commodities which are not allocated by means of competitive pricing. However, while the allocating criterion in the private market and the one suggested for allocations outside this market are indeed synonymous, a problem of measurement, which market prices avoid, remains a problem in the provision of non-market goods.

The willingness-to-pay for any commodity can be approximated by the area under the aggregate demand curve for that commodity. This may be illustrated in a simple hypothetical example given in Figure 1. This curve is simply a demand schedule indicating the varying quantities, Q, (on the horizontal axis) which consumers would purchase given varying prices, P (on the vertical axis), of this particular commodity. This demand curve is drawn as a straight line in this example simply for expositional convenience.



This demand curve indicates that at zero price 4 units will be demanded, that is, consumers would want to take this many if they were free. At a price of $1, 3 will be demanded; at $2, 2 would be demanded, etc.

In the example given in Figure 1, it is indicated that no units would be purchased at a price of $4, but that at $3, 1 unit would be consumed. Thus it is apparent that people are willing to pay $3 for 1 unit but not $4. That is, the willingness-to-pay for 1 unit is less than $4 but is at least $3 and may well be more than $3. If the demand curve is straight as drawn in Figure 1, then the willingness-to-pay value associated with 1 unit by the consumers or users of this commodity is $3.50–*i.e.*, they would be willing to pay $3.50 for 1 unit rather than give up the opportunity to acquire the good. This is so even though they in fact face a market price of $3. Thus the demand curve, by conveying the information that no units would be purchased at $4 but 1 unit would be at $3, thereby gives the further information that the willingness-to-pay for 1 unit is between $3 and $4, and if the curve is a straight line is $3.50.

Similarly, the demand curve indicates that while 1 unit is taken at $3, 2 would be purchased at $2. Therefore, the willingness-to-pay for a second unit is at least equal to or greater than $2 but not $3. Again, if we know the demand curve to be a straight line, the willingness-to-pay for this second unit is $2.50. Thus 2 units are purchased at a price of $2, but the total willingness-to-pay for the 2 combined is $3.50 for the first plus $2.50 for the second, or a total of \$6. The purchasers pay \$4 for the 2 units at \$2 per unit, but they would have been willing to pay up to a total of \$6 rather than go without.

If no price were charged 4 units would be taken. The total value of the willingness-to-pay for the 4 units would be equal to the entire area under the demand curve. In the case presented in Figure 1, this would be the sum of: \$3.50 times 1 unit, \$2.50 times 1 unit, \$1.50 times 1 unit, and \$0.50 times 1 unit, or a total of \$8. Thus, even though a zero price is charged and therefore no money is paid, the economic value of the 4 units is still \$8.

The willingness-to-pay on the part of beneficiaries has been the operational definition of benefit for most benefit-cost studies performed for water resource development projects and is compatible with other benefit measures. For example, the willingness-to-pay for irrigation water is the area under the demand curve for such water in the project area, and is operationally calculated as the difference in net earnings between farming operations with and without the irrigation water provided by irrigation projects. Thus a farmer would have a willingness-to-pay for this water of an amount equal to the difference in net earnings. This correctly measures the value of the water.

The significance of using the concept of willingness-to-pay, measured by the area under the demand curve, as a guide for social choice may be illustrated using the demand curve in Figure 2. If we first assume that Q_1 of the commodity is produced and sells for a price of P_1 the total revenue will then be Q_1 times P_1. If a project is now undertaken to increase the quantity of the commodity supplied by an amount Q_1 Q_2, the price in the market would drop to P_2. The total revenue for all of the commodity produced by the old supplier and that of the new project is now equal to Q_2 (the new output) times P_2 (the new price). This new total revenue ($P_2 Q_2$) is far less than the original level of total revenue ($P_1 Q_1$), but this does not mean that the value of the total output of the commodity decreases as a result of the addition of output. Only the total revenue has decreased. The added production of the good has added to the total value. The apparent contradiction is one between financial returns and economic value, and is resolved by going beyond simple market returns and using the concept of the willingness-to-pay for increased outputs as an indication of the increased economic welfare. This value for the additional output Q_1 to Q_2 is the area under the demand curve over the range Q_1 to Q_2. The total area added under the demand curve as a result of the project is the area Q_1 Q_2 B A, clearly a significant addition to economic welfare even though the

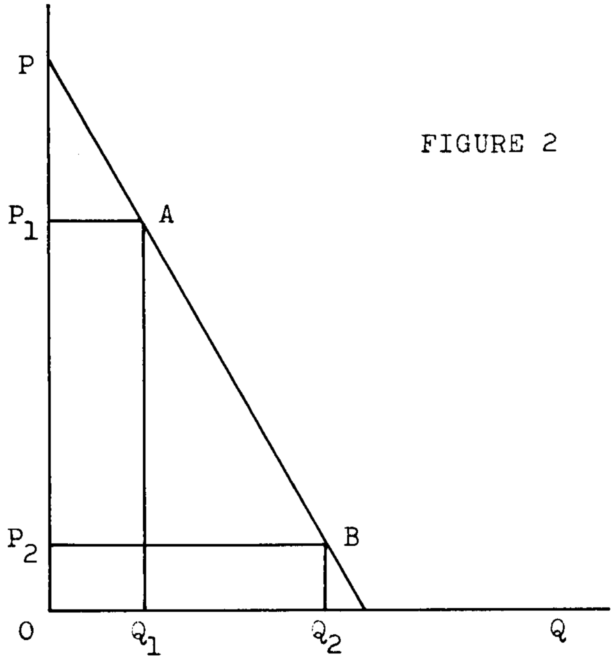


FIGURE 2

total revenue of the output has decreased as a result of the additional output. Total revenue computed by a single price is simply an inadequate measure of total economic value if the change in output is sufficiently large to cause a change in the price. This problem is common in the case of investments which represent large increments to the relevant market and often occurs in the case of natural resource development activities.

EVALUATION OF RECREATION BENEFITS

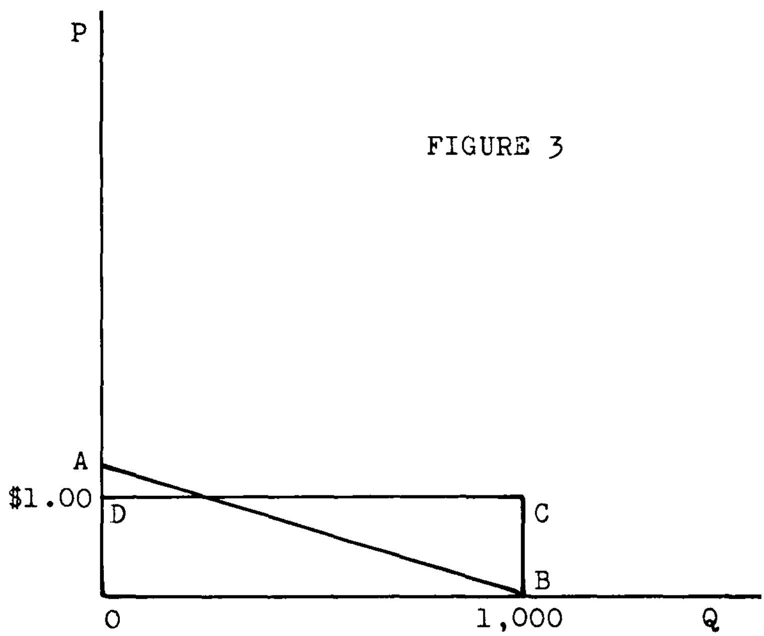
The criterion for the evaluation of the benefits to users of recreation afforded by alternative developments of natural resources is the willingness of users to pay for the alternative opportunities, and is measured by the area under the appropriate demand curve.

Current federal agency practice of benefit analysis has imposed a severe restriction on the proper evaluation of alternative kinds of recreation development. This is particularly the case in situations such as that posed in the evaluation of recreation alternatives on streams having substantial values stemming from their wild or scenic characteristics.

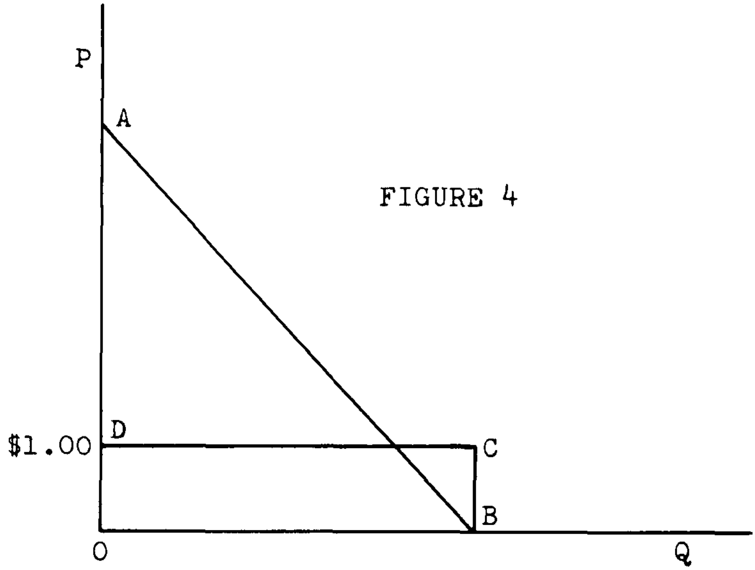
The path commonly followed by federal agencies is that outlined in Supplement One to Senate Document 97.[2] This essentially takes the recreation benefit to be the total number of recreation days estimated to occur at a site, multiplied by a unit day value which is taken to be, for most forms of recreation, a value of from \$.50 to \$1.50 per day. The value chosen within this range is usually dependent upon the amount of development at the site. Supplement One also outlines other values for specialized types of recreation, proposing a schedule of from \$2 to \$6 for these forms.

While the method is in a sense correct, in attempting to associate the value of recreation benefits with a figure that purports to be what consumers of the commodity would be willing to pay for the opportunity to participate, it is in fact a very poor operational definition of this criterion.

The major difficulty may be seen by reference to Figure 3 and Figure 4. In the case of Figure 3, it is indicated that without a user charge, *i.e.*, at a zero price, 1,000 people will visit the site. This is a point on the relevant demand curve AB. The value of the recreation benefit is then taken, using the criterion of Supplement One, to be 1,000 times, say, \$1, or \$1,000. This is the area OBCD in Figure 3.

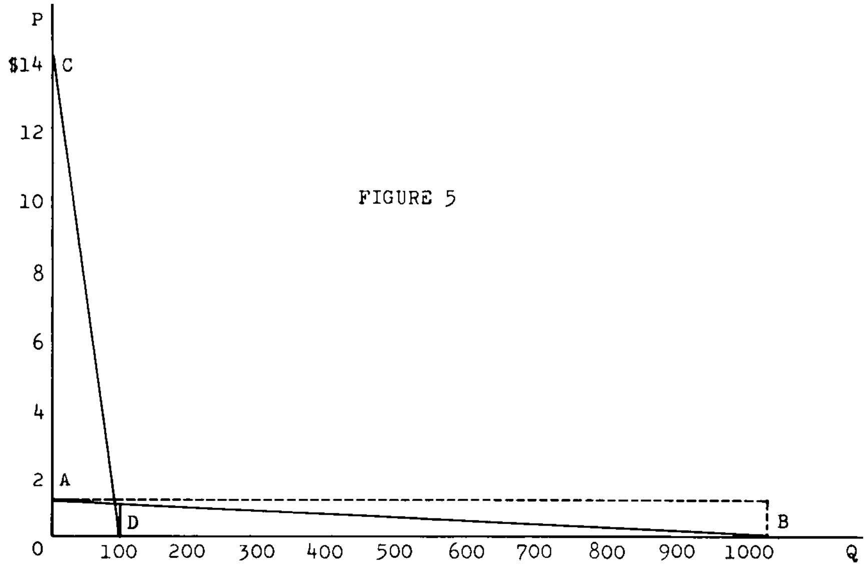


2. President's Water Resources Council, Policies, Standards, and Procedures in the Formulation, Evaluation, and Review of Plans for Use and Development of Water and Related Land Resources, S. Doc. No. 97, 87th Cong., 2nd Sess. (Supp. No. 1, 1964).



However, this approximation of the benefits seriously overstates the benefits as given by the correct criterion of the area under the demand curve AB—the area OBA. Similarly, in Figure 4, the Supplement One derived benefit would again be $1,000 whereas the correct benefit would be far larger as given by the area under the demand curve OBA. The point is that the criterion does not allow for the vast differences that may be expected in the slopes of the appropriate demand curves. In particular, the unit values are not related to relative scarcities of the recreation opportunities. The unit value is simply invariant to the major determinants of the actual value of the services provided. This can seriously bias the evaluation in cases comparing two alternative recreational uses of a resource area.

The bias problem may be illustrated using Figure 5. Here let it be assumed that one form of recreation that may be provided can be represented by the demand curve AB. The alternative form of recreation which can be provided can be represented by the demand curve CD. These cases might under some circumstances realistically represent reservoir and natural stream situations respectively. In the first instance, a total visitation of 1,000 users would be indicated at this zero price. There is, of course, no reason for the demand curve to intersect the price axis at $1. The value chosen does not depend on this or is not even related to this. Indeed the unit value procedure ignores this important attribute of the value question. However, if we again take $1 as the value of a recreation-day, the recreation benefits



would be estimated to be $1,000. The alternative form may only have 100 users indicated at the zero price. Using the same $1 this form of recreation would have an indicated benefit of but $100.

When the same or even similar unit values are used to estimate the values of recreational development alternatives, the procedure is then effectively rigged to ascribe the greatest value to the alternative attracting the greatest number of people. The evaluation then simply reduces to a head count. Such an unidimensional measure of value is grossly inappropriate.

When we turn to the demand curve for each of the two forms of recreation assumed in Figure 5, quite a different result from that using unit values is indicated. If the demand curve for the alternative attracting the larger total number of users is given by AB the actual benefit is the area under this demand curve, or approximately $500. The area under the second demand curve corresponding to the alternative attracting 100 recreation-days is indicated to be $700. Thus in this case the actual value or benefits stemming from the alternative which attracts relatively infrequent use exceeds the value or benefits of the alternative recreation development which attracts 10 times as many users.

The important point to be noted here is that the benefits depend significantly upon the slope of the relevant demand curve. It may well be the case that for some forms of recreation the demand curve is likely to be very flat (*i.e.*, generally elastic or highly responsive in terms of visitors to small price changes) and for other forms of recreation is likely to be far more vertical (inelastic over much of its range or with little visitation effect resulting from price changes). The implications for many cases involving the free-flowing and structural development alternatives on streams may well be significant.

Outdoor recreation associated with mass use may quite likely parallel the demand curve AB in Figure 5, whereas the demand curve for rare or unusual types of recreation is very likely to approximate the demand curve of CD in this diagram. Thus, the issue depends very much on the relative elasticities or slopes of the demand curves for the different forms of outdoor recreation that are provided or associated with each alternative. If, indeed, the demand curves are very much steeper for forms of recreation which attract smaller numbers of people than other forms, the total value of this use of the resource may still exceed that associated with recreation use that caters to larger total numbers of participants.

Current official methods of evaluating recreation benefits, as given in Supplement One to Senate Document 97, are simply incapable of indicating this important difference. A more realistic examination of the relative values must go beyond the total number of visits that can be expected from the alternatives and examine the likely elasticities or slopes of the demand curves which are associated with each of the types of use.

Economists, market researchers, and merchants have long been able to demonstrate that the demand for any commodity is dependent upon its price, the price of other related goods and services, the incomes of the individuals in the market, and the tastes and preferences of these individuals. In the case of outdoor recreation most is publicly provided and available at zero or nominal charge. Consequently, the role of conventional prices is largely muted; its relative availability becomes a far more important factor. The second factor, namely the availability or price of related goods and services, is equally as important for recreation as it is for other goods and services.

It is well known that for any good or service having close substitutes the demand curve is going to be very elastic, that is, have a less steep slope. Thus, the quantity demand for a given brand of a standard product having many substitutes, in the form of other brands, will fall off very drastically if the producer attempts to raise the price above that of the substitutes. In this case, consumers will simply switch to an alternative brand which is still available at the original price.

In the case of goods or services without close substitutes, it is equally well known that the demand curves exhibit far more inelastic properties, such as those of demand curve CD of Figure 5. Consider a typical textbook comment on this phenomenon:

> The determinants of the price elasticity of demand for a commodity can be put under three headings: (1) the number and closeness of its substitutes, (2) the commodity's importance in buyers' budgets and, (3) the number of its uses.
>
> Of the three determinants, the substitutes for a commodity are the most important. If a commodity has many close substitutes, its demand is almost certain to be elastic, perhaps highly so. If price goes up, consumers buy less of the commodity and more of its substitutes. . . . The more narrowly and more specifically a commodity is defined, the more close substitutes it has and the more elastic is the demand for it. The demand for a particular brand of mentholated toothpaste is more elastic than the demand for toothpaste in general, which is more elastic than the demand for dentifrices (pastes, powders, and liquids). The pattern is similar throughout the entire range of commodities.
>
> If a commodity is so defined that it has perfect substitutes, then its elasticity of demand is perfect, or infinite.[3]

This can be directly related to the case of flat water recreation that might be made available in an area and the natural stream type of recreation that may already exist.

We should expect that if the recreational opportunities provided by or associated with the free flowing water are derived from a resource of limited quantity, then even though the numbers of actual visitors making use of this resource for recreational purposes in its present form may well be relatively small, that the demand curve associated with this use is very steep and that the total value would be relatively large for the number of visitors. If there are numerous alternative flat water areas with substantial excess capacity, we would expect the opposite to be true. This would particularly be the case if there were uncongested flat water areas nearer to the population centers in a region.

The main point is that there are two considerations for estimating the relative values of the two general types of recreation opportunities that may be provided. The first relates to the numbers of people that might be attracted, *i.e.*, to the position of the curve on the horizontal axis. The second relates to the willingness-to-pay of the users, *i.e.*, the slope of the demand curves. Even were the total use of the area to be significantly greater under the flat water alternative,

3. D. Watson, Price Theory and Its Uses 46 (2d ed. 1968).

this alone would not insure that the total benefits are larger. Indeed, there is every reason to suggest that the relative difference in elasticities of the demand curves may in some cases more than compensate for any possible greater use, and in many others indicate smaller increases in net value attributable to development.

Extensive empirical estimates of demand curves for recreation facilities do not exist. Some data has, however, been collected from water-related sites and has been used to construct demand curves in several cases. These analyses shed some light on the question of the degree of elasticity of demand curves and its relationship to the number of substitutes available. The empirical evidence that exists does not generally allow a determination of the specific values, but the results of these studies of recreation use are fully consistent with the expectation of a flatter demand curve for recreation sites as the number of close substitutes increases.

It has been possible to relate the numbers of visitors that are attracted to different recreation areas to various characteristics of the site and the user populations, such as the amount of facility development, the size of the lake, the distance from population centers, the per capita income of residents, and so forth. If such relationships can be statistically determined it is also possible to derive approximations of a price quantity schedule or demand curve.[4] If it can be established that a significant relationship exists between the number of visitations to a given reservoir and the number of alternative reservoirs available to the populations in the region, then the demand schedule will indicate this higher degree of elasticity. That is, if the alternative reservoirs are important in forecasting the number of visitors expected at a given site, more credence can be given the increased elasticity due to the availability of substitute sites.

In one study, which utilized data from a series of existing reservoirs in Texas, a statistically significant relationship was found to exist between the number of people visiting the different reservoirs and the populations in the surrounding counties, the per capita income of the residents of these counties, the cost of travel between the origin of visitors and the reservoir site and, importantly for our purposes, the proximity to competing reservoirs.[5] That is, the greater the number of reservoirs existing in a region, the fewer number of visits would be made to any given reservoir.

4. M. Clawson and J. Knetsch, Economics of Outdoor Recreation (1967), especially ch. 11. *See also* Cesario and Knetsch, *The Time Bias in Recreation Benefit Estimates,* Water Resources Research (June 1970).

5. Texas Water Development Board, Economic Evaluation of Water-Oriented Recreation in the Preliminary Texas Water Plan, No. 84 (1968).

Another study used visitor information obtained from a series of 84 recreation sites in Pennsylvania, New Jersey, and New York.[6] A principal component of the attractions at these sites was the availability of water based outdoor recreation. This study found the level of attendance at each site to be related to distance from population centers, per capita incomes of the resident populations, the facilities available at the individual sites, congestion at the sites, and significantly, the number of alternative sites available to the different population centers. Again, the more alternatives available, the fewer people were found to visit any given site. The subsequent demand curve was therefore significantly affected and was flatter for those areas having more substitute areas available.

While the analysis of use data in these and other cases has certainly not been as extensive as would be desired, the results are consistent, and are consistent with the notion that the greater the number of substitute areas available, the flatter the expected demand curve for these areas and consequently the smaller the value that can be ascribed to recreation on them. Thus, for projects located in a region for which the population centers have larger numbers of substitutes available to them a proper accounting of the recreation benefits must take this explicitly into account in estimating not only the expected number of visitors but the resultant slope of the relevant demand curve. This is, after all, nothing more than an extension of the very common sense notion that, having more of something of which we already have many, and especially if largely unused, can be expected to be worth less than having more of something of which we have relatively few.

6. Cesario, Goldstone, and Knetsch, *Outdoor Recreation Demands and Values,* Battelle Memorial Institute (1969).