DISCUSSION

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The Hell's Canyon issue, analysed by Krutilla, exemplifies the growing problem of conflict between industrial exploitation of natural resources and preservation of their aesthetic and recreational values. This particular example embodies two special features important to the analysis; (i) the alternatives between "development" and "preservation" are mutually exclusive, and (ii) the decision to "develop" (though not to "preserve") is irreversible. These features give the problem its special interest, because the first does not lend itself easily to traditional marginal analysis, and the second is inconsistent with the usual assumptions in optimal growth theory wherein both investment and disinvestment are continuously possible.

Krutilla's contribution is substantial: it is an important extension of the literature on benefit-cost analysis (which already owes a good deal to him); it clarifies some of the perplexing conceptual problems in evaluating non-priced services of resources; and it is an ingenious demonstration of how careful identification of threshold values can short-cut some of the worrisome difficulties in evaluating environmental benefits. In view of the increasing frequency with which development proposals of this kind are being encountered, it is an eminently timely contribution.

Much of Krutilla's paper deals with how the assymetric time trends in the values for for the two alternative allocation regimes can be identified and worked into the benefit-cost framework in the context of the Hell's Canyon proposal. I should like to comment here on a couple of theoretical issues involved in the analysis of preservation values.

Krutilla postulates a conventional demand curve for recreation days at the site; "... the schedule which a discriminating monopolist could exact as prices ..." Under free access, the total value accrues to the recreationists as consumer surplus.

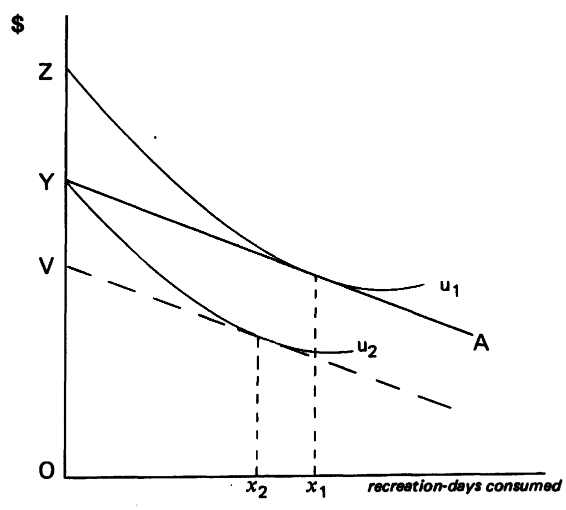

Figure 1.

In Figure 1, OY is the recreationists' total income, YA is a budget line the slope of which reflects the marginal cost of a recreation day (assumed constant), and u_1 and u_2 are indifference curves. Standard analysis suggests that the recreationist would consume Ox_1 recreation days.

Following Hicks, we can identify at least two measures of consumer surplus. The amount by which the consumer's income would have to be increased to fully compensate him for exclusion from the recreational opportunity, YZ, is the "price equivalent" measure of consumer surplus. The maximum amount the consumer would be willing to pay to retain the privilege of using the recreational site is YV, the "price compensating" measure.[1] Krutilla chooses the latter (which for normal goods is smaller) although it is probably the less appropriate for evaluating an existing asset.[2]

The difficulty arises in integrating this concept of consumer surplus into an aggregate demand curve, and inferring from it the effect of pricing. Krutilla has, on the horizontal axis of his demand curve, the quantity of recreation consumed — presumably measured in recreation-days. But note that if all or part of the recreationists' consumer surplus — YV in Figure 1 — was actually appropriated through some levy, the recreationist would alter his consumption from x_1 to x_2. The extent to which he would adjust consumption depends upon the marginal cost of a recreation-day and the shape of the indifference curves, but (unless recreation is a Giffen good) he will consume less.

To be consistent, then, the units of demand should be expressed not in numbers of recreation-days but in numbers of recreationists. Such a demand curve would represent the aggregate of recreationists' consumer surpluses YV in Figure 1 and would thus measure the maximum amount they would collectively be prepared to pay to retain the recreational opportunity. Conceptually, a perfectly discriminating monopolist could exact this amount in sales of visitor licenses (as opposed to a per-day charge) without eliminating any visitors, although each would consume less. This is important, because Krutilla goes on to discuss the implications of crowding and the control of crowding through price-rationing. Crowding, however, is a function of the number of recreation-days consumed.

Krutilla's concept of the carrying capacity of a recreational site implies that the quality of the recreational experience is adversely affected by crowding externalities. This is an awkward phenomenon to deal with in terms of conventional demand analysis. A given demand curve must relate to a product of constant quality, and hence any change in the degree of congestion calls for a new demand curve.

In Figure 2, D_1 represents the demand curve for recreation at an uncrowded (high-quality) site. D_2, D_3 and D_4

represent the demand curves for the same site under successively more crowded conditions. Here, demand is expressed in units of consumption — say visitor days per year — and quality is measured by some index of crowding — such as visitors per mile of trail.[3]

Krutilla implies only one level of quality, constant up to the fixed limit of the site's capacity. But while the site might be assumed fixed (in the Ricardian sense) it is more realistic to regard the capacity of the site to accommodate visitors as amenable to expansion at additional cost (e.g., by building more miles of trail).

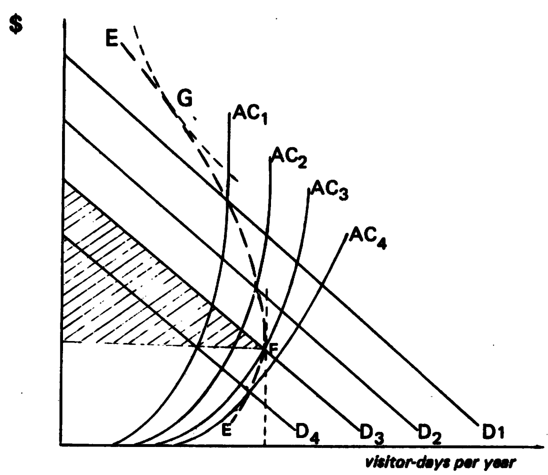

Figure 2.

Thus we might impose on Figure 2 a sheaf of upward-sloping average cost curves ($AC_1 \ldots AC_4$); one corresponding to the quality underlying each of the demand curves. There is now a pair of average cost and revenue curves for each quality standard, and their intersection indicates the price that would be dictated by average cost pricing.[4] If both sets of curves are symetrically shaped, a line joining these equilibrium prices will curve outward from the vertical axis like EE in Figure 2.[5]

Now consider alternative objectives, and the implications for choice among the various prices and quality standards. To maximize gross revenues, we would choose the regime indicated by the tangency of a rectangular hyperbola with EE (i.e., point G). To maximize total use, we would choose that indicated by the point of tangency of a vertical line with EE (i.e., point F). If the demand curves were parallel, we would choose the same point (F) to maximize net benefit: since the price just covers costs for all points along EE, net gain is in the form of consumer surplus, and the area under the demand curve above price will be maximized by the triangle that extends furthest to the right (shaded in Figure 2). It seems likely, however, that the demand for higher quality recreation would be less price-elastic, in which case consumer surplus would be maximized at a price higher than that consistent with the densest use.

Space prevents further exploration of this approach here, but the question of congestion (and other aspects of quality) deserves explicit analysis in assessing the benefits of particular recreational resources.

FOOTNOTES

1 See Peter H. Pearse, "A New Approach to the Evaluation of Non-Priced Recreational Resources," *Land Economics* 44(1):87-99.

2 See Krutilla *et al*, "Observations on the Economics of Irreplaceable Assets" (unpublished manuscript: Resources for the Future Inc., September 1970)

3 It may appear paradoxical that the quantity demanded at any price is lower under crowded conditions when it is greater consumption which causes the crowding itself. But the demand schedules along tell us nothing, of course, about what is possible to attain in the way of quantity and quality.

4 Alternatively, of course, we could demonstrate marginal cost prices.

5 I am indebted to Gideon Rosenbluth for this demonstration.