

# Comparing Estimated Wilderness Costs Among National Forests

Gene E. Campbell  
and

David W. Countryman

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**ABSTRACT**—Wilderness costs can be extremely variable among national forests. For example, the Willamette (in Oregon) has 471,245 fewer acres suitable for wilderness and a maximum marginal cost per acre of wilderness 820 times greater than on the Beaverhead (in Montana). Marginal cost curves developed from linear programming models can depict relative wilderness costs among forests and thus assist society in comparing economic trade-offs, making wilderness selections cost-effective, and isolating those forests where wilderness decisions have greatest impact.

The optimal contribution from National Forest System (NFS) lands to the National Wilderness Preservation System (NWPS) is a problem in social choice which must be resolved within the political system. Difficulty in resolving this issue reflects the growing interest and importance of wilderness allocations in terms of preservation and opportunities foregone. For society to provide additional wilderness and increase output of other forest commodities as well, wilderness selections must be cost-effective (Jones et al. 1978). Thus, economic cost estimates of allocating land to wilderness are needed.

Estimates of direct pecuniary costs of designating land for wilderness have been determined for two western national forests, the Beaverhead in southwestern Montana (Jones 1976) and the Willamette in west-central Oregon (Campbell 1979). The forests' respective linear programming models were used to estimate costs, but the techniques are applicable to any similar forestwide linear programming model (e.g., the USDA Forest Service's FORPLAN).

Although both forests lie west of the 100th meridian, they differ in size, topography, species composition and productive potential. The Beaverhead consists of approximately 2.1 million acres, of which 40 percent is classified as commercial timberland and about 70 percent is considered roadless. Important uses include timber, water, forage, wilderness, and nonwilderness recreation. The Willamette, which has much higher timber values than the Beaverhead, contains 1.7 million acres of which about 17 percent are roadless. Primary uses are wood, water, wildlife, wilderness, and non-wilderness recreation.

This article compares estimated costs on the basis of economic efficiency criteria from the two forests. An increase in economic efficiency is represented by an increase in total forest net present worth (NPW), given a specified management regime. Further, costs were derived from values of foregone opportunities resulting

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from additional allocations to wilderness. No attempt is made to suggest optimum contributions to wilderness from each forest, but rather to illustrate the magnitude of economic trade-offs at increasing amounts of wilderness and the effect that different forest situations have on costs. The differences show the necessity of incorporating economic criteria into the political process if society is to avoid incurring excessive costs for additional wilderness.

### Methods

The approach used to estimate costs on the Willamette National Forest is based on linear programming methods described by Jones et al. (1978) for the Beaverhead. For both forests, the direct pecuniary cost of supplying wilderness consists of three components: (1) the administrative costs of managing a wilderness area, (2) increases in nonwilderness management costs as productivity on nonwilderness sites is increased to meet commodity constraints, and (3) increases in values of products and services given up as a consequence of increasing wilderness size.

The Beaverhead and the Willamette models contain a linear programming matrix in which the information necessary for cost estimation is stored. This information includes important forest commodities, expected benefits and costs, production coefficients, commodity target levels, suitable combinations of management activities and land areas, appropriate management and acreage constraints, and scheduled planning periods.

Cost curves representing wilderness supply were constructed from marginal cost estimates at specific wilderness acreages. Marginal cost is defined as the reduction (or gain) in net present worth when one additional acre is designated as wilderness.

$$\text{Marginal cost} = NPW'_a - NPW'_b$$

where  $NPW'_a$  = net present worth of forest commodity and service flows without additional wilderness, where  $r$  equals a specified discount rate, and  $NPW'_b$  = net present worth of forest commodity and service flows with an additional acre allocated to wilderness.

Also, given that an optimal solution to the linear programming model exists, the value of the dual variable associated with the wilderness commodity equals the marginal cost of an additional acre of wilderness. The full set of cost estimates was derived by beginning with existing wilderness and sequentially solving each forest's individual model to maximize NPW under wilderness constraints of increasing size. Sequential solutions were continued until the maximum potential on each forest was reached. Supply schedules generated in this way give minimum cost of allocation at each acreage level subject to the particular management regime, since the lowest cost areas are allocated first and the most expensive last.

### Management Constraint Sets

Wilderness costs were estimated under several management constraint sets:

Willamette Constraint Set 1 (W1) is the proposed action in the Willamette National Forest's Final Envi-

ronmental Statement. Emphasis is on multiple use while maintaining water quality and basic soil productivity. Timber is to be maintained on good sites, and opportunities for investment in work which would maintain current annual allowable harvest are to be pursued (USDA Forest Service 1977).

Willamette Constraint Set 2 (W2) is identical to Set W1 except that all commodity outputs are free to take any nonnegative value.

Beaverhead Constraint Set 1 (B1) emphasizes livestock forage production and places moderate emphasis on wood fiber production, wilderness study, and recreation opportunities. At the time the set was formulated, it seemed to be the most likely direction of future management (Jones 1976).

Beaverhead Constraint Set 2 (B2) is identical to Set B1 except that all commodity outputs are free to take any nonnegative value. The exception allows greater freedom in optimally allocating the forests' resources. Thus, economic efficiency is maximized under constraint sets W2 and B2, given their respective management regimes.

Marginal cost curves for the Beaverhead are given in figure 1 (Jones 1976) and are expressed in present value terms, discounted at a rate of 6.87 percent. Wilderness

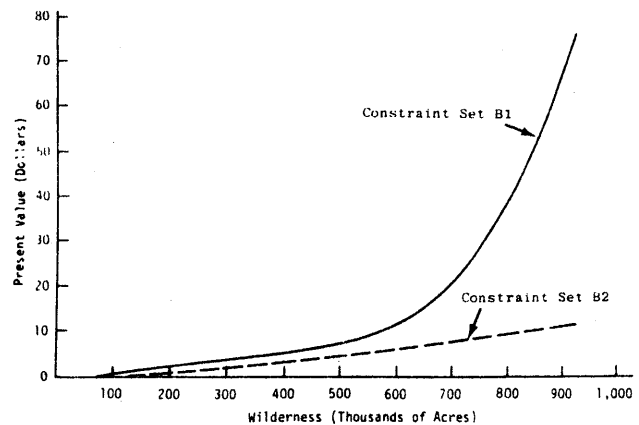


Figure 1. Estimated marginal cost per acre of wilderness for constraint sets B1 and B2 on the Beaverhead National Forest (Jones 1976).

allocation ranges from 72,379 to 927,440 acres under both constraint sets, with marginal cost rising to about \$76.00 per acre under Set B1 and to \$12.00 under Set B2. After wilderness allocation exceeds 500,000 acres, marginal cost curve B1 increases much more rapidly than does curve B2. The major factors accounting for this divergence are the significantly greater value of foregone commodities and services under Set B1, and the increasing nonwilderness management costs.

Figure 2 presents marginal cost curves for the Willamette National Forest (Campbell 1979). For each constraint set, W1 and W2, 201,649 additional acres were designated wilderness through sequential solutions of the forest's model. If all roadless and undeveloped areas were so classified, the wilderness component would increase from the existing 15 percent to over 30 percent of total forest acres. All cost estimates are given in present value terms, discounted at a rate of 7 percent.

Under W1 and W2, marginal cost begins increasing at existing wilderness (approximately 254,750 acres) and increases to just under \$10,000 per acre at an allocation of 456,195 wilderness acres. Foregone timber

and intensive recreation contribute most to cost. Other commodities that decrease in total output, and thus raise marginal cost as wilderness increases, are forage, dispersed recreation, auto-associated recreation, water yield, big game hunting, and small game hunting.

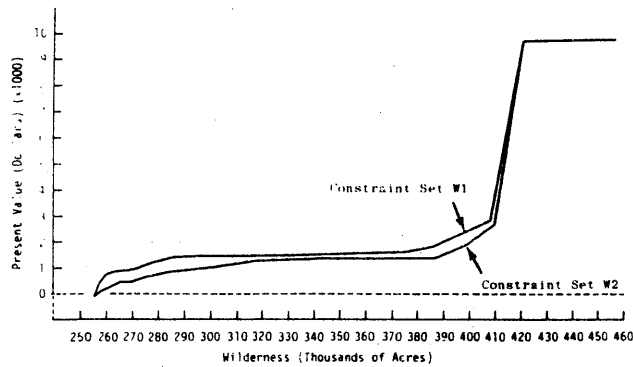


Figure 2. Estimated marginal cost per acre of wilderness for constraint sets W1 and W2 on the Willamette National Forest.

In general, the model first designated very steep and rocky areas with marginal to medium sawtimber (255,000 to 265,000 acres), with very steep to steep upland slopes possessing medium to large sawtimber (285,000 to 375,000 acres) next. Third to be allocated were steep to moderately steep uplands and lower slopes with primarily large sawtimber (395,000 to 415,000 acres). Areas with rolling slopes and upland flats containing medium to large sawtimber were designated last (420,000 to 455,000 acres).

Relative to the Beaverhead, increases in nonwilderness management costs are unimportant with respect to influencing wilderness price. This is shown by the convergence of curves W1 and W2, and divergence of curves B1 and B2.

Once wilderness size on the Willamette exceeds approximately 400,000 acres, society incurs rapidly increasing costs. Whether or not society will pay these cost increases is a function of nonquantifiable wilderness benefits.

### Comparison of Wilderness Cost Curves

Figure 3 presents comparisons between the Willamette and Beaverhead for constraint sets, W2 and B2. The most striking difference is the magnitude of marginal costs. Under W2, marginal cost ranges from -\$88.72 to \$9,851.04, a change of \$9,939.76 resulting from a change in wilderness acres of 201,445. In contrast, on the Beaverhead marginal cost under B2 ranges from about -\$0.50 to \$12.00, a change of \$12.50 as wilderness increases by 855,061 acres. Maximum marginal cost on the Willamette is 820 times greater than on the Beaverhead. This result is even more striking in that marginal cost estimates for the Willamette National Forest are based on 471,245 fewer wilderness acres (at maximum wilderness size for each forest). Thus, the Beaverhead has the potential of designating, at a fraction of the cost, over twice as many wilderness acres as is possible on the Willamette.

### Discussion

Economic efficiency is not the only criterion important in evaluating wilderness. Other important elements of an "ideal" Wilderness System include ecosystem and

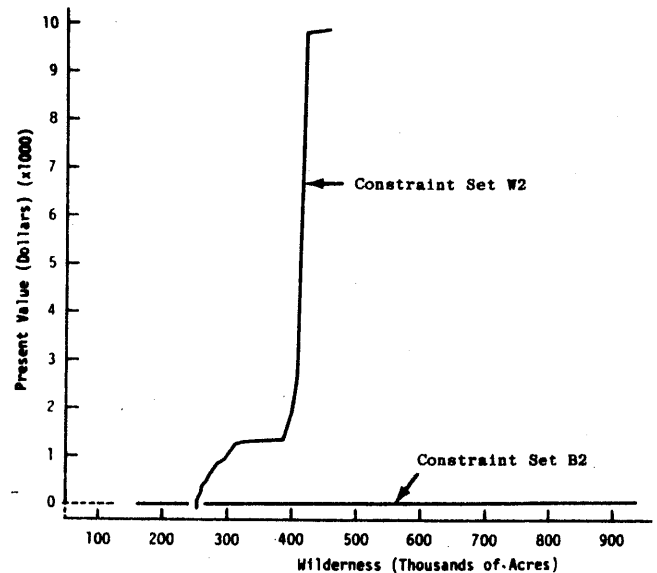


Figure 3. Estimated marginal cost per acre of wilderness for constraint sets B2 and W2 on the Beaverhead and Willamette national forests, respectively.

landform representation, accessibility and distribution, and the presence of certain wilderness-associated wildlife habitats (USDA Forest Service 1978).

However, the Willamette and Beaverhead national forests' wilderness marginal cost curves illustrate the importance of integrating economic criteria into the selection process. Marginal cost curves can be used to isolate those forests where wilderness decisions have greatest impact or to enable society to compare economic trade-offs. ■

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THE AUTHORS—Gene E. Campbell is assistant professor in the Department of Forestry at Auburn University, Auburn, Alabama, and David W. Countryman is professor in the Department of Forestry at Iowa State University, Ames.

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