A Preliminary Estimate of the Value of Recreational Use on the Upper Clark Fork and Its Tributaries

Dr. John Duffield

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SUMMARY

This paper provides an estimate of the value of recreation on the Upper Clark Fork and its tributaries. It is based on a use survey undertaken by Carol Hagmann in 1978-79 (Hagmann, 1979) and on traffic surveys on Rock Creek by the Lolo National Forest (1959-1980). The value of these visits (consumers surplus) has been estimated by use of the travel cost method. The basic idea is that the price of admission to use of free public resources is what it costs to get there. By examining the relationship between travel costs and the number of vists from different surrounding towns and counties, one can derive a demand curve for river use. This approach is attractive in that it is based on actual behavior. The methodology used here follows that outlined by the U.S. Water Resources Council (WRC, 1979). Travel costs were corrected to include travel time.

Statistical estimations of the demand functions yielded highly significant correlations between visit rates and travel costs. Measures of income and substitution were less successful. Both of these results have antecedents in empirical literature as discussed below. Benefit estimates were not paricularly sensitive to alternative specifications (log-linear and semi-log estimates were generally within 5% to 10% of each other). Preliminary results based on demand functions specified for each of ten river sections (Little Blackfoot, Flint Creek, Warm Springs Creek, etc.) indicate fairly separate local markets dominated by the nearest large town. Due to this finding and data limitations, a simultaneous multi-equation model was not developed. The only non-local market appears to be Rock Creek, with total visits by non-residents alone exceeding the total visits to all other rivers in the area. This area is clearly a regional resource. The development of a regional model to correctly assess Rock Creek is beyond the available data and resources for the present study. The variation in demand for the different Clark Fork

sites is an interesting pattern that appears to result from the proximity of large towns and the qualities of the rivers themselves. Use also varied significantly from winter to summer on the main stem of the Clark Fork.

A critical assumption of the travel cost model is that the cost of any given visit can be attributed to the recreation site being surveyed. This is clearly not true for visits with multiple destinations. For example, a visitor on Rock Creek from Colorado may be on his western fishing tour, with Yellowstone Park or the Big Hole his next stop. The entire cost of his trip from Colorado cannot be allocated to Rock Creek alone. Unfortunately, the frequency of multiple destinations was not established in the available survey data. Since multiple destinations are far more likely for visitors from a considerable distance away, benefits were estimated in two ways. A minimum estimate was derived based on resident use only from areas less than 150 miles away (250 for Rock Creek). This approach suggests annual use in 1978-79 on the Upper Clark Fork and its tributaries was worth at least $500,000 to Montana residents. This is an average of $3.79 per visit during this period. A high estimate would include the value of all resident visits (from even the most distant towns) and also would include the value of non-resident visits (at the same "high" average value found for residents of $5.62 per visit). This high estimate would suggest annual use worth about $1,400,000 in 1978-79.

The true value of recreation use in this area probably lies between these extremes. Whatever the precise value, the basic finding is that the instream uses of the Upper Clark Fork have a very substantial value. The corresponding market price for resources capable of yielding $500,000 to $1,400,000 per year in 1979 would be around 12 to 33 million dollars at early 1981 price levels.

In the following sections, the methodology and findings of this Study are presented in greater detail. Appendix A provides the specific town by town benefit estimates for each of the river areas. Appendix B is a brief literature review of the travel cost methodology. Appendix C lists the parameters of the regression estimates by river.

INTRODUCTION

This study provides a preliminary estimate of the economic value of recreational use of the Upper Clark Fork and its tributaries.

In order to evaluate a resource, it is necessary to describe its physical use or output and the dollar value of that use.

Recreation Use Data

Recreational use is measured here (in physical terms) by the number of visits per year. Based on a fairly large (3,324 observations) sample, Carol Hagmann has estimated the total number of visits on the Upper Clark Fork from June 1978 to May 1979 at 102,631 (Hagmann, 1979). The distribution of this use (excluding private campgrounds) by river section is reported in Table 1. Approximately 75% of this use was by Montana residents. In the summer season (June to September), use ranged from 16,005 visits on the lower section of the Upper Clark Fork (Milltown Dam to Rock Creek Bridge) to only 1,714 visits on Warm Springs Creek (Table 1). Winter use was sampled only on the main stem of the Clark Fork, and averaged about half of the use level during the summer season.

Hagmann's study did not provide a comparable sample for Rock Creek. However, the Lolo National Forest has been monitoring use of that area since the early 1950's. Their estimate for 1979 is 154,400 recreational visitors, 52% of which are Montana residents. The total use of the Upper Clark Fork and its tributaries in 1978-79 was about 225,000 visits (excluding about 32,000 additional visits to private campgrounds in the area) (Table 1); over two-thirds of this use was for Rock Creek.

The Travel Cost Method

The value of these visits has been estimated by use of the travel cost method. This approach is one recently adopted by the U.S. Water Resources Council (WRC) for recreation evaluation of federal water projects.

Table 1

Total Estimated Recreational Visits[1]
by Area 1978-79
Upper Clark Fork

River Section	Resident Visits	Non-resident Visits	Total
I. Summer			
Lower Clark Fork[2]	11,734	4,271	16,005
Middle Clark Fork[3]	5,439	1,786	7,225
Upper Clark Fork[4]	2,572	845	3,417
Little Blackfoot	11,733	3,852	15,585
Flint Creek	8,995	2,953	11,948
Warm Springs Creek	1,290	424	1,714
SUBTOTAL Summer	41,763	14,131	55,894
II. Winter			
Lower Clark Fork[2]	4,010	1,317	5,327
Middle Clark Fork[3]	1,838	603	2,441
Upper Clark Fork[4]	5,097	1,673	6,770
SUBTOTAL Winter	10,945	3,593	14,538
III. SUBTOTAL Clark Fork	52,708	17,724	70,432
IV. Rock Creek Annual	80,906	73,494	154,400
V. TOTAL	133,614	91,218	224,832

NOTES:

1. Source for Rock Creek visits was Jim Rice, Lolo National Forest Supervisor's Office. Other Clark Fork visits derived from Carol Hagmann.

2. Milltown Dam to Rock Creek Bridge.

3. Rock Creek to Garrison.

4. Garrison to Warm Springs Creek.

The methodology is described in detail in the WRC Principles and Standards (Federal Register, December 1979). Appendix B provides a brief review of the economics literature on the travel cost method, which had its beginning in the work of Clawson (1965) and Knetsch (1963). The basic idea is that the price of admission to use of free public resources (such as the Upper Clark Fork) is what it costs to get there. By examining the relationship between travel costs and the number of visits from different origin points, one can derive a demand curve for river use. For example, in Table 2, the relationship between travel costs and visits per capita is described for the Lower Clark Fork section. The average visitor from very close by towns such as Clinton has to travel only several miles to the most heavily used access point on this section of river (use weighted centers were calculated for each river section). As one might expect, use by Clinton residents is very high: 1.321 visits per capita yer year. By contrast, visits per capita from Missoula, 16 miles away, were only .107 visits per capita and from Butte, 102 miles away, much lower at .003.

Table 2 only reports visits by Montana residents. As seen in Table 1, approximately 25% of visits recorded on sections of the Upper Clark Fork (except Rock Creek--50%) were by non-residents. A large share of these were from very distant areas including California and Illinois. Because survey information was limited on these visitors and because it is highly unlikely that the Upper Clark Fork was the major (or only) destination of their trip, these visits were not included in the sample on which the demand functions are based. This means that the estimates reported below are conservative (or minimum estimates) to the extent that non-resident visits are not included.

Table 2

Visits versus Travel Cost
on the Lower Clark Fork Section
(Milltown to Rock Creek)
(Summer 1978)

County/Town	Estimated Visits[1]	1978 Population	Visits per Capita	One way Distance	Travel Cost
Clinton	2,487	1,882	1.321	2	.30
Bonner/Milltown	315	1,115	.283	12	1.77
Missoula	7,145	66,703	.107	16	2.36
Florence	140	4,537	.031	36	5.32
Granite	140	2,800	.050	47	6.94
Corvallis	35	2,194	.016	59	8.71
Powell	350	7,600	.046	63	9.30
Hamilton	105	14,369	.007	63	9.30
Mineral	105	3,800	.028	73	10.78
Lake	210	18,300	.011	83	12.25
Sanders	105	8,500	.012	91	13.44
Lewis & Clark	175	41,000	.004	98	14.47
Silver Bow Area	140	53,700	.003	102	15.06
Gallatin Area	35	70,200	.000	185	27.32
Cascade Area	70	98,500	.001	207	30.56
Yellowstone Area	175	129,800	.001	322	47.54

1. Based on Hagmann, 1979.

P_t = Passengers/vehicle during study period t

M_t = average miles per hour travel during period t

dij = one way distance from origin i to destination j

The WRC suggests (based on extensive studies in the literature of transportation economics) that travel time be valued at one-third the average hourly wage rate for adults, and one-twelfth for children.

The average hourly wage in Montana during the study period was $6.76. It was assumed that the average travel speed (including stops) was 45 miles per hour and that travel was by personal vehnicle. From Hagmann's interview data, the number of people per vehicle was found to be 2.74 in summer and 1.90 in the winter. The average cost of operating an automobile also varied considerably between the summer (June-September) 1978 sample period and the winter (September '78-May '79) sample period. Gas during the summer averaged 65¢/gallon and in the winter period 74¢/gallon. Based on a number of references (U.S. Department of Transportation, 1979; Johnson, 1980; and U.S. House of Representatives, 1979), variable automobile costs were estimated at .091¢/mile in the summer and .099¢/mile in the winter. Hagmann did not sample for the number of children under 12, but did record whether recreationists were a "family group" or another of four types of groups. An analysis of this data suggests that children under 12 were probably about 25% of summer recreationists but only about 5% of winter recreationists. Based on these numbers the weighted average travel cost in summer was estimated to be 7.4¢ per mile and in the winter 10.2¢ per mile (assumed all adults).

Specifications of the Equations: Substitute and Income Variables

In addition to travel costs, it is expected that the demand for recreation will also be in part a function of other variables such as income and the availability of substitutes. For example, looking again at the

For one section of river, the Lower section of the Clark Fork (summer), the effect of including all visits from Idaho was explored. This added three additional origin points in the Moscow, Lewiston, Coeur d'Alene, and Sandpoint areas. However, because Idaho's population is concentrated on the far western edge of the state (with of course almost no population in the Selway-Bitterroot and other undeveloped areas immediately west of Missoula), the addition of Idaho had only a very slight effect on the estimate. Accordingly, for consistency with the other river sites in this study, the Idaho points were excluded.

For Rock Creek, where half the visits are non-resident, there is a possibility that Rock Creek is the major destination of a substantial portion of non-resident visitors. Unfortunately, the Forest Service data is inadequate for an accurate study of this use.

<u>Travel Costs</u>

In order to statiscally estimate this apparent relationship between distance and visit rates, the cost of traveling a given distance was estimated. This is a function of the variable costs of operating an automobile (in ¢ per mile, including gas and depreciation), the average number of people in the vehicle, and the value of people's time spent traveling.

The parameters which must be estimated to identify travel costs are summarized by the following relationship:

$$TC_{ij} = \frac{V_t}{P_t} + \frac{W_t \cdot M_t}{60} \quad 2d_{ij}$$

where:

TC_{ij} = round trip travel cost per visit from origin i to destination j

V_t = variable cost per mile of transportation (maintenance and repairs, gasoline) during study period t

Lower Clark Fork (Table 2) there are more visits per capita (.004) from Helena (Lewis & Clark County) than from Butte (.003) (Silver Bow) even though these towns are essentially the same distance. This may be due to people being relatively better off economically in Helena or due to better alternative sites (the Jefferson and Big Hole) near Butte. Accordingly, equations were estimated that included not only travel cost, but measures of income and the availability of substitutes as explanations of visit levels. The major alternative approaches to specifying a demand relationship for multiple sites are: (1) a multi-equation model with cross-price terms constrained to be symmetric, (2) a multi-equation unconstrained model, and (3) the single equation gravity model. The most appropriate approach for a baseline analysis appears to be #2 (as discussed in detail in Appendix B). Specifically, a separate demand equation was estimated for each site, using three different mathematical forms of the relationship for most of the river sections (subscripts omitted):

(1) Semi Log $V = e^{\alpha} . e^{b_1 TC} . e^{b_2 INC} . e^{b_3 SUB2 + E}$

(2) Log-linear $V = e^{\alpha} . TC^{b_1} . INC^{b2} . SUB^{b3} + E$

(3) Linear $V = \alpha + b_1 TC + b_2 INC_i + b_3 SUB2 + E$

where: α, b_i = parameters to be estimated

E = error term

V_{ij} = visits per capita from origin i to destination j

TC_{ij} = round trip variable travel cost from the point of origin i to the river section j

INC_i = per capita personal income of the county of origin

$SUB2_i$ = a measure of the availability of substitutes which is travel cost to the next two closest river recreation areas for each point of origin, weighted by the "attractiveness" of each river.

Since all Montana cities (except Helena and Butte) are located on major rivers, a measure of the availability of substitutes had to be something more than just the distance to the nearest river. Following Cesario and Knetsch (1976), measure of the attractiveness or quality of river use was derived. Hagmann's study reports a comparison of other Montana Rivers to the Upper Clark Fork. An index was developed from her study based on the percent of "more" or "much more" desirable answers over "about the same" answers. This index is reported in Table 2. For example, the Madison was rated more or much more desirable than the Upper Clark Fork by 30.8% versus 28% who said it was about the same for an index of 1.10. This index was used to weight travel costs to different rivers. Initially the substitute variable was this "weighted travel cost" to the nearest river. However, this variable was not found to be significantly correlated to visits for any river area. An alternative substitute measure was defined and used in the estimate reported: taking the sum of the weighted travel cost to the two nearest alternative river sites. (This is similar to the approach taken by Smith (1980).)

A limitation here is that many rivers beyond the immediate study area were not compared in Hagmann's survey. In addition, there is some arbitrariness in determining the nearest heavily used access point for a given substitute river and town. This is an area for further work.

As noted above (and discussed in Appendix B), the major alternative approach to using separate demand functions for each river section is to estimate simultaneously a multiple-equation regional model. One approach suggested in the literature (Burt and Brewer, 1971, and Cicchetti et al, 1976) requires the use of linear equations to satisfy the constraint of symmetric cross-price (or "cross-travel cost") elasticities. However, linear equations appear to result in a poor fit as reported below. The non-linear gravity type model developed by Cesario and Knetsch (1976)

Table 3

Attractiveness of Substitute Rivers

Major Rivers[2]	N	X More or Much More Desirable	Y About the Same	X/Y
Madison	175	30.8%	28.0%	1.10
Big Hole	196	33.7%	33.7%	1.27
Yellowstone	165	22.5%	22.4%	1.00
Missouri	166	14.4%	30.1%	.48
Middle Forks of Flathead	217	30.9%	28.1%	1.10
10 Most Visited Rivers[1]				
Blackfoot	61	45.9%	44.3%	1.04
Bitterroot	56	26.8%	50.0%	.54
Fish Creek	11	63.7%	27.3%	2.33
Lower Clark Fork	21	47.6%	38.1%	1.25
Jefferson	17	64.7%	23.5%	2.75
Lolo Creek	11	36.4%	54.5%	.67
Beaverhead	10	80.0%	20.0%	4.00
Gallatin	11	54.6%	27.3%	2.00
Swan	7	57.2%	42.9%	1.33
Clearwater	10	30.0%	70.0%	.43

1. Derived, Table 16, p.43, Hagmann (1979).

2. Derived, Table 13, p.40, Hagmann (1979).

also appears to have promise for a regional model. However, in addtion to the theoretical and empirical (data requirements, fit) of these models, for the problem at hand, each of the river sections appears to be a relatively separate local market. The majority of the users sampled by Hagmann (65%) never visited the Madison, Big Hole, Yellowstone, Missouri or Flathead Rivers, and 80% none or less than once a year. Almost 40% of all visits excluding Rock Creek were from Missoula and almost half gave "fishing" or "close to home" as reasons for selecting the Clark Fork over other streams. Even within the Upper Clark Fork area, visits are dominated by the nearest large town (Butte for the Upper section, Helena for the Little Blackfoot, etc.). And even for relatively nearby areas, there are often no sample visits from the larger towns -- for example, no visits on the Upper Clark Fork section (winter) from Missoula, even though overall use on that river section was heavier in the winter season (due to heavy waterfowl hunting) than in the summer. Accordingly, the multiple independent equation estimate appears to be valid for most of the river sections analyzed. The exception is probably Rock Creek, which is clearly a regional resource. More data would be needed to accurately characterize regional substitutes for this area.

Regression Results

Using multiple regression analysis, the parameters for each river section were estimated. For example, the best equation (log-linear) explaining visits per capita on the Upper Clark Fork (Garrison to Warm Springs Creek) is the following:

$$V/p = e^{57.60} TC^{-1.677} INC^{-7.019} SUB2^{.843}$$

The basic findings for all sections are summarized in Table 4. Detailed specifications of the regression estimates for all rivers are in Appendix C.

In general the linear specification provided a very poor explanation of the relationship; in most cases only about 15% of the variation in visit rates for different towns in the sample was explained by the linear equations. (This corresponds to an adjusted coefficient of determination $\bar{r}^2$ (reported in Table 3) of .15). The log-linear and semi-log specifications did substantially better, generally providing an explanation of 70% to 90% of the variations in visit rates. In all 22 cases reported but one (semi-log for Warm Springs Creek -- probably due to the very small number of towns in the sample), travel cost was a significant explanatory variable. Per capita income and the measure of the availability of substitutes (travel cost to alternative rivers) were less successful, with coefficients significantly different from zero at the 90% confidence level in only three cases each. These findings are generally consistent with the results reported in the economics literature. It appears that the visit rate -- travel cost relationship is generally curvi-linear. The poor relationship to per capita income is also widely reported for travel cost models. It has been found (Gum and Martin, 1977) that the likelihood of participating in outdoor recreation is mainly dependent on personal preferences and attitudes, rather than county average statistics like income. The substitutes coefficient, where significant, was in all cases positive. This is in accordance with theory and suggests that when the costs of travel to a substitute area are higher (less nearby substitute areas), there will be greater demand for the river being examined.

Recreation Benefits

After the visit rate equations are specified, the benefits of a river to a specific town or county are derived by integrating this equation with respect to travel cost. A definite integral is solved with the limits of

Table 4

Summary of Specification Alternatives

Area	Equation[1]	Significance of Regression Coefficients: (Travel Cost) VARØ2	(Income) VARØ3	(Substitutes) VARØ4	$\bar{r}^2$	Number of Origins in Sample
Little Blackfoot	1	X[2]	+(80%)	(+)X	.813	14
	2	X			.798	14
Warm Springs Creek	1	(80%)			.556	4
	2	X	+(80%)		.797	4
Lower Clark Fork	1	X	X	(-)(75%)	.71	16
(Summer)	2	X			.85	16
	3	X	+(80%)		.17	16
Lower Clark Fork	1	X			.846	7
(Winter)	2	X	-(80%)		.743	7
Middle Clark Fork	1	X			.605	7
(Summer)	2	X			.593	7
Middle Clark Fork	1	X	+(80%)	(+)X	.818	7
(Winter)	2	X			.522	7
Upper Clark Fork	1	X			.830	7
(Summer)	2	X	+(80%)		.967	7
Upper Clark Fork	1	X	(-)X		.88	9
(Winter)	2	X	(-)X	(+)X	.97	9
Flint Creek	1	X		(+)80%	.655	15
	2	X			.797	15
Rock Creek	1	X			.396	27
(FS data)	2	X			.576	27

Notes:

[1] Semi-log=1; Log-linear=2; Linear=3.

[2] x = significant at 90%

of integration equal to the travel cost from the point of origin to the travel cost at which visit benefits are presumed to go to zero. This value is then multiplied times the population of the given town or area. The basic assumption underlying this calculation is that individuals will react uniformly across origin zones or towns to any given change in travel cost. Any hypothetical increase over travel cost actually faced by a given population can be viewed as something like the price of admission. (The integration is mathematically equivalent to estimating the consumers surplus under the demand curve for river recreation.)

This benefit estimate can be computed on the assumption that the prices of all other sites are fixed at the level prevailing when the visitation data were gathered. For situations where multiple price (travel cost) changes are taking place (for example if a new site was being introduced into the area) it would be necessary to develop a more sophisticated model of substitution effects (as discussed in Appendix B).

When the integration is done for all towns or counties using a given river and summed up, one has an estimate of the river's recreational value. For example, Table 5 reports such a calculation for the Lower Clark Fork.

The estimated benefits of recreation on the Lower Clark Fork section to residents in 1978-79 was $2,734, while benefits to residents of Missoula were $24,734. Areas much further away from the Lower Clark Fork section than Missoula but equivalent in population, such as the Gallatin County area had, as expected, much lower total benefits ($2,035) reflecting fewer visits. Similar calculations were made for all other river sections and seasons and are reported in Appendix A.

The major unknown in this estimate is whether some of the recorded visits were for multiple destinations. If someone from Shelby is observed

Table 5

Lower Clark Fork Summer Benefits

County/Area	Distance	Population	Benefits at Max[1]	Benefits at 150[2]
Clinton	2	1,882	2,734	2,652
Bonner/Milltown	12	1,115	507	459
Missoula	16	66,703	24,734	21,856
Florence	36	4,537	906	711
Granite	47	2,800	446	327
Corvallis	59	2,194	285	191
Powell	63	7,600	927	604
Hamilton	63	14,369	1,758	1,142
Mineral	73	3,800	401	237
Lake	83	18,300	1,688	897
Sanders	91	8,500	708	341
Lewis & Clark	98	41,000	3,137	1,371
Silver Bow Area	102	53,700	3,918	1,636
Gallatin Area	185	70,200	2,035	--
Cascade Area	207	98,500	2,199	--
Yellowstone	322	129,800	--	--
			46,383	32,424

1. Presumes that all visits, out to the furthest origin in the sample, are included on the valuation.

2. Presumes that only visits from areas less than 150 miles away are to be included in the sample.

fishing near Missoula, the full cost of his travel can be allocated to the Lower Clark Fork only if that is his only purpose for the trip. The further visitors travel, the more likely they are visiting a number of sites -- perhaps Glacier Park, or Missoula relatives, or just passing through. In both Hagmann's and the Forest Service Rock Creek studies there is no information on multiple destinations. Accordingly, two assumptions were made to define low ("best conservative estimate") and high estimate. For the low benefit estimate, it was assumed that all visits originating in areas more than 150 miles from the river site had no value attributable to that river. This was done for all sections except Rock Creek. For the latter, a 250 mile limit was used for the low estimate. This is because of the substantially higher visitation at Rock Creek by distant Montana counties (a total of 31 counties were represented in the eight day 1976 O/D survey by the Forest Service) and the substantial non-resident use associated with its reputation as a "Blue Ribbon" trout stream. The "high" estimate assumed that benefits are derived up to the travel cost level corresponding to the most distant origin. In the Lower Clark Fork example (Table 4), the low and high estimates are $32,424 versus $46,303 annual recreation benefits respectively.

The "best conservative" (low) estimate for Montana residents for all river sections is summarized in Table 6. This table also reports the exact specification of the equation used. In general, the equation with the higher adjusted coefficient of determination ($\bar{r}^2$) was used. In six cases the log-linear specification was best, and in four cases the semi-log specification was best.

The influence of alternative specifications is reported in Table 7. In general, the semi-log estimates are slightly higher. The only difference between the two specifications is that the log-linear generates a constant

Table 6

Best Conservative[1] Estimate of 1978-1979 Recreational Value of the Upper Clark Fork

River Section	Specification	$\bar{r}^2$	Benefits (Residents only)
Lower Clark Fork Summer	Log-linear on TC	.850	34,424
Winter	Semi-log on TC	.846	42,940[2]
SUBTOTAL			75,364
Middle Clark Fork Summer	Semi-log on TC	.605	14,364
Winter	Semi-log on TC, INC, SUB2	.818	9,994
SUBTOTAL			24,974
Upper Clark Fork Summer	Log-linear on TC	.830	9,076
Winter	Log-linear on TC, INC, SUB2	.970	10,801
SUBTOTAL			19,877
Flint Creek Summer	Log-linear on TC	.797	26,045
Little Blackfoot Summer	Semi-log on TC, INC, SUB2	.813	20,653[1]
Warm Springs Creek Summer	Log-linear on TC	.797	2,890
SUBTOTAL (excluding Rock Creek)			169,803
Rock Creek Annual	Log-linear on TC	.576	327,846
TOTAL			497,649

1. Estimate is for Montana residents only and presumes that all visits originating from areas greater than 150 miles away (250 miles for Rock Creek) have no value due to the possibility that the travel costs incurred are for multiple destinations.

2. Adjusted by the ratio of max to 150 in Log-linear.

elasticity. The net effect empirically is that benefits are slightly higher for origins near the extremes with the log-linear model. There is (as has been observed in the literature) no basis for choosing between the two on theoretical grounds. The empirical difference appears to be slight for large samples (the Rock Creek semi-log and log-linear estimates, with 27 different origins, differ by only about .5%). The effect of including the other explanatory variables (income and substitute) where significant is to lower benefits on average by about 17% (Table 7). The net impact, given generally positive substitute and income coefficients, is to shift the visit-travel cost relationship closer to the origin for reduced benefit estimates. It is somewhat encouraging to find that benefits are rather stable across alternative specifications.

Based on the preceding analysis, Table 8 provides a summary of annual estimated benefits on the Upper Clark Fork and its tributaries. The high and low estimates for Montana residents are derived as reported previously. The regression estimates summarized in Tables 4, 5, 6, and 7 and Appendix A are all based on Montana residents only. As discussed previously, non-resident visitors to the Upper Clark Fork almost certainly have multiple destinations in Western Montana if not the western United States; to include them in a visit travel cost relationship for say, Flint Creek, would strongly bias the results upward. However, these visitors do undoubtedly derive some benefit from their use of these areas, and they do incur some travel costs specific to the rivers being analyzed. The approach used here was to assume that once non-resident visitors are in the general area of a given river, they will face the same travel costs as residents in deciding between a visit to, say the Madison or North Fork of the Flathead versus Rock Creek. Accordingly, the average value of a Montana resident visit to Rock Creek (the low at \$4.09 and the high at \$6.81) was used to value non-resident visits to Rock Creek. For the Lower Clark Fork, where

Table 7

Influence of Regression Specification on Estimated Benefits

River Section - Season	Regression Specification			
	Log-linear (TC)		Semi-log (TC)	Other
	Max[7]	at 150[6]	Max[7]	Max
Lower Clark Fork - Summer	46,383	32,424	56,728	55,599[3]
- Winter	25,317	24,353	44,640	
SUBTOTAL	71,700	56,777	101,368	
Middle Clark Fork - Summer	13,498	13,498	14,980	
- Winter	8,768	8,768	12,828	9,994[4]
SUBTOTAL	22,266	22,266	27,808	
Upper Clark Fork - Summer	9,076	9,076		
- Winter	19,439	18,853		10,801[1]
SUBTOTAL	28,515	27,929		
Flint Creek - Summer	50,587	26,045		
Warm Springs Creek - Summer	2,890	2,890		
Little Blackfoot - Summer	25,366	15,915	38,883	32,918[2]
SUBTOTAL - excludes Rock Creek	201,324	151,822		109,312[10]
Rock Creek - Annual	1,052,139	625,660[5]	1,058,647[8]	
TOTAL	1,253,463	777,482	1,308,698[9]	

NOTES:

1. Log-linear on INC, SUB2, TC.
2. Semi-log on SUB2, TC.
3. Semi-log on TC, INC, SUB2
4. Semi-log, includes SUB2, INC, TC.
5. Benefits including origins up to 250 miles away.
6. Benefits including origins up to 150 miles away.
7. Benefits including origins up to maximum distance on the sample.
8. Semi-log up to 250 miles is $639,569.
9. Approximate: includes Log-linear (max) where semi-log not estimated (4.4% higher).
10. Is 17% lower than the corresponding estimates based on TC alone of 127,879.

non-resident use was much lower, an additional correction was made. All of these river sections are paralleled by major through routes, including, for the main Clark Fork, I-90. Some of these "visits" at picnic spots and overnight campgrounds are no more than incidentally connected to the river. Hagmann did ask in her survey the reason for choosing the Clark Fork over other rivers; there is in these answers a substantial difference between residents and non-residents. These answers are summarized in Table 9. Answers indicating a probable low value to be placed on this particular visit to the river might include: "convenient", "passing through", "rest stop" or "visiting area". Non-residents gave these answers 37% of the time versus 7% for residents. By comparison, there are a number of answers recorded in Table 8 which suggest active choice of the Clark Fork, such as "fishing" or "recommended". The ratio of "active choice" type answers to all answers (except "other") is .57 for non-resident versus .92 for resident. Accordingly, for lack of a better correction, non-resident benefits on the Lower Clark Fork are recorded in Table 9 at 57% of resident. [This is being conservative; one could argue that the ratio .57/.92 or .62 is more appropriate.]

Based on these considerations, the annual value of recreation on the Upper Clark Fork and its tributaries in 1978-79 was between $828,000 and $1,362,000 (Table 8). A more conservative estimate, just counting Montana resident visits, would be between about $500,000 and $750,000. It should be pointed out that these values are real in that they are based on people's actual behavior in choosing how to allocate time and money. While the values generated are quite substantial, on the order of $1 million per year, the related "price" in dollars per visit seems quite reasonable at $3 to $7 depending on the river section. These values are, by the way, well within the range suggested by the WRC in its much more approximate "unit day value" approach of $1.50 to $4.10 per day for general

Table 8

Summary of Annual Estimated Recreation
Benefits in the Upper Clark Fork in 1978-79
(early 1979 constant $'s)

River Section	Recreational Visits in 1978-1979			Estimated Average (Resident) $/visit	Estimated Annual Value		
	Resident	Non-Res.	Total		Resident	Non-resident	Total
I. Best Conservative Estimate[1]							
Rock Creek	80,906	73,494	154,400	4.05	327,846	297,814	625,660
Other Clark Fork	52,708	17,724	70,432	3.22	169,803	32,530	202,333
TOTAL	133,614	91,218	224,832	3.79	497,649	330,344	827,993
II. High Estimate[2]							
Rock Creek	80,906	73,494	154,400	6.81	551,324	500,815	1,053,13
Other Clark Fork	52,708	49,923	102,631	3.82	201,324	108,691	310,01
TOTAL	133,614	123,417	257,031	5.62	752,648	609,506	1,362,15

NOTES:

1. Assumes that all Montana resident visits orginating from areas more than 150 miles away (250 for Rock Creek) have no value attributable to the Upper Clark Fork. Non-residents are assumed to derive the same average $/visit value as residents. Only 57% of non-residents on "other Clark Fork" are assumed to derive any value from their visit attributable to thse rivers.

2. Assumes that all resident visits (no matter from how far away) have value attributabl to the Upper Clark Fork. Visits at private campgrounds at Bearmouth Chalet, KOA in Deer Lodge, and the Drummond City Campground (26,529 summer and 5,670 winter) are included as "non-residents" under "other Clark Fork". All non-resident visits under "other Clark Fork" counted at 57% of resident values.

recreation or $5.50 to $16.30 for specialized recreation [WRC Reference Handbook (fiscal year 1981)].

Present Worth of Benefits

A final step is to make the reported values more or less comparable to the market price for ownership of a given resource, such as an acre of land. The market price today of a property (water or land) capable of generating a million dollars of revenue in 1978-79 will depend on several factors. One is the discount rate applied to future revenues. A 7-3/8% real rate is used here, as required by the WRC on all federal water projects. In times of 12% inflation, this implies a nominal interest or discount rate of 20%. Secondly, any expected real increase in the revenue stream (over and above inflation) needs to be included. Historical trend data for Rock Creek is reported in Exhibit 1 for 1959 to 1979. Excluding the recent increase in residential traffic, Lolo Forest engineer Jim Rice estimates that 4% to 4-1/2% is a good conservative figure for the long-term growth in Rock Creek recreational traffic. Accordingly, a 4% increase was included for the Rock Creek present value. However, due to the possibility of eventual congestion effects, this growth rate was only taken out to twenty years (to the year 2000) and zero growth assumed thereafter. The carrying capacity of Rock Creek and the negative effects of congestion costs (Cicchetti and Smith, 1976) on benefits is an issue requiring further study.

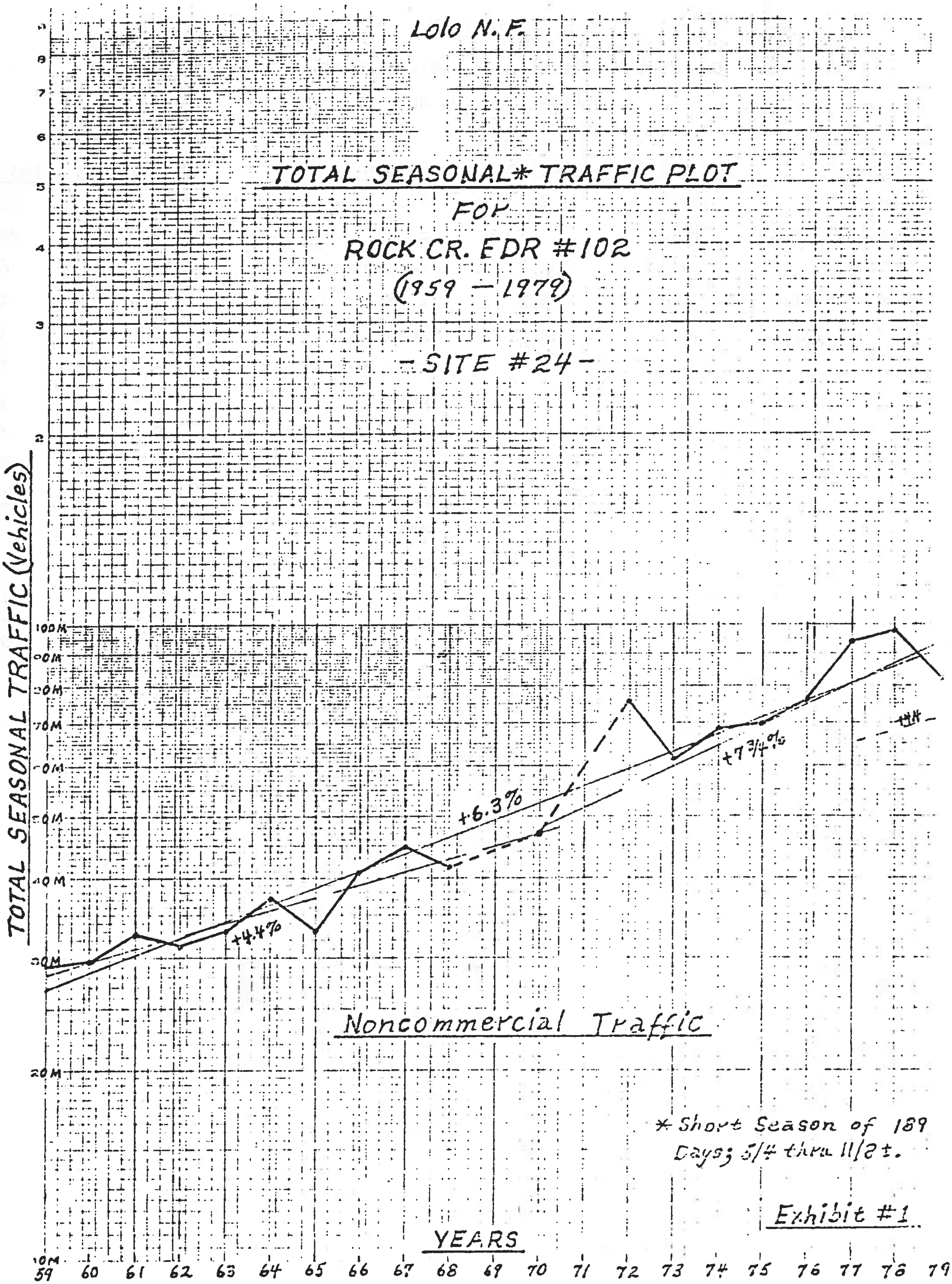
For the remainder of the Clark Fork, benefits may be assumed to follow population growth in the respective market areas. Benefits for the Clark Fork area as a whole are dominated by use from Missoula. Based on preliminary 1980 census estimates, Missoula County grew at 2.6% per year from 1970 to 1980 (from 58,263 to 75,432). The most recent forecast for Missoula by the State Department of Community Affairs [DCA, July 1978] is for 1.24% annual growth to year 2000 for Missoula. However, these rates may prove to be low as the DCA prediction of

Table 9

Comparison of Reasons for Visiting the Clark Fork:
Resident versus Non-resident

Reason	Non-resident	Resident
convenient	15.4	2.7
passing through	15.8	1.7
rest stop	3.3	.3
visiting area	2.6	2.3
TOTAL	37.1	7.0

Reason	Non-resident	Resident
fishing	11.7	22.4
close to home	4.8	24.1
recommended	10.3	6.3
like the area	2.9	5.0
scenic	6.2	3.4
easy access	5.5	3.8
quiet	4.4	3.1
clear stream	0.0	2.2
old time spot	.7	2.2
working area	.4	2.0
good picnic spot	2.2	.6
never been before	0.0	1.7
good float	0.0	1.6
TOTAL	49.1	78.5



SOURCE: Appendix B, Traffic Assessment, FDR-Lolo National Forest [Appendix to the "Transportation Study Report," May, 1980, USDA Forest Service, Region 1

Table 10

Present Worth of Recreation Benefits
on the Upper Clark Fork
(early 1981 $'s)

River Section	Present Worth		
	Resident	Non-resident	Total
I. Best Conservative Estimate[1]			
[2]Rock Creek	8,451,000	7,677,000	16,128,000
[3]Other Clark Fork	3,377,000	647,000	4,024,000
TOTAL	11,828,000	8,324,000	20,152,000
II. High Estimate[2]			
[2]Rock Creek	14,212,000	12,910,000	27,123,000
[3]Other Clark Fork	4,004,000	2,161,000	6,165,000
TOTAL	18,216,000	15,071,000	33,288,000

NOTES:

1. See Table 7 for specification of assumptions.

2. Present worth factor is 21.13 based on 4% real growth in use to 2000 and no growth thereafter; 7-3/8% discount rate specified by the U.S. Water Resources Council for fiscal 1981 [October 1980]. Includes 22% inflation from early 1979 to early '81 $'s.

3. PW factor is 16.30 based on continuous 1.2% growth in use and 7-3/8% discount rate.

actual Missoula County population for 1987 had already been reached by 1980. A more recent statewide forecast has been recently published by the Bureau of Economic Analysis; they forecast a .8% increase in Montana population 1978-2000 [B.E.A., November 1980]. A more complete and accurate forecasting model would include population growth in other nearby counties, the possible effects of increased income and higher travel costs on recreational use. In addition, changing tastes and values may be leading to increased participation. In lieu of better information, the DCA estimate of 1.24% was used here to forecast increased benefits on the Upper Clark Fork. This is probably conservative in light of the actual trend recorded on Rock Creek, the high actual population growth in Missoula County, and the improving water quality of the Upper Clark Fork. It was assumed that this relatively low growth rate would not result in congestion effects for the foreseeable future.

Based on the preceding discussion, the present worth of recreation benefits on the Upper Clark Fork is summarized in Table 10. The numbers reported there include a correction to early 1981 dollars (based on 22% inflation in the general price level between the mean time of the surveys in early 1979 and early 1981). The minimum and possibly best estimate for use of these areas by Montana residents is about $12 million. This is based on the assumption that all estimated visits from areas further than 150 miles away (250 for Rock Creek) have no value. A similar minimum estimate including non-residents is for a $20 million value (Table 8). This number is less defensible as an estimate as it assumes non-residents on average place the same value on their visits as residents.

The high estimate assumes that the travel costs for all estimated visits, from however far away, could all be attributed to Upper Clark Fork river destination. Thi estimate <u>is</u> probably high, at around $33 million.

Suggestions for Further Study

In the judgment of the author, the estimates derived here for the Upper Clark Fork and its tributaries (excluding Rock Creek) probably bracket the actual value of this recreation use. Since the survey data utilized was not designed with a travel cost analysis in mind (unfortunately this is typically the case), substantial narrowing of the range of the estimate could be achieved by a more comprehensive survey. Specifically one would want to know the prevelance of multiple destinations of the actual number of children under 12, and how recreationists valued their travel time. In addition, the sample size for a number of the river sections was small and resulted in standard errors for total visits on the order of 25 to 30 percent of the mean estimate. Substantial work could also be done to refine the measure and expand the set of substitute rivers.

In contrast to the estimates for the other Upper Clark Fork sections, the Rock Creek numbers must be regarded as preliminary. Given the high proportion of non-resident use, the problem of multiple destinations is of greater significance. In addition, Rock Creek is clearly a regional resource and requires, if not a full regional model, at least a good definition of regional substitutes.

These improvements could be done to provide a better economic baseline estimate of recreation. It would also be of interest to expand the scope of study to consider the relationship between changes in water quality, levels of flow, alternative uses of the river (agricultural and industrial) and the associated impact on recreation benefits (as discussed in Appendix B).

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APPENDIX A

Benefit Estimates

This appendix provides the origin-specific benefit estimates for each river section in the study. The estimate reported in every case is for the regression specification noted in Table 6, in the main text, "Best Conservative Estimate." The Lower Clark Fork section-summer is not listed here, since it is included in the text by way of example as Table 5.

A-1

Benefits Lower Clark Fork Winter--Semi-log on TC

County/Area	Distance	Population	Benefits at max
Clinton	6	2,531	2,635
Missoula	17	50,669	37,373
Huson	35	3,862	1,614
Deer Lodge Area	62	10,598	1,876
Mineral	74	2,958	355
Flathead Area	132	50,998	787
Cascade Area	177	115,085	--
			44,640

A-2

Benefits Middle Clark Fork Summer--Semi-log on TC

County/Area	Distance	Population	Benefits max
Granite	1	2,800	1,645
Powell	31	7,600	1,511
Missoula	47	69,700	7,739
Deer Lodge	57	13,900	1,068
Lewis & Clark	67	41,000	2,175
Butte Area	97	50,800	842
Cascade	156	86,400	--
			14,980

A-3

Benefits Middle Clark Fork Winter--Semi-log (Includes SUB2 & INC)

County/Area	Distance	Population	Benefits max
Granite	5	2,800	1,143
Garrison	24	1,755	369
Missoula	44	69,700	7,369
Deer Lodge	60	5,845	351
Butte Area	100	53,700	732
Flathead Area	151	50,000	30
Casecade Area	159	86,400	--
			9,994

A-4

Upper Clark Fork Summer Benefits--Log-linear on TC

County/Area	Distance	TC @ .14765	Population	TC @ -.625	Benefits max	Benefits at 150
Powell	12	1.77	7,600	.700	1,272	
Deer Lodge	14	2.07	13,900	.635	2,055	
Silver Bow	28	4.13	39,800	.412	3,236	
Granite	43	6.35	2,800	.315	146	
Lewis & Clark	68	10.04	41,000	.237	1,181	
Missoula	91	13.44	69,700	.197	1,186	
Cascade	157	23,18	86,400	.140	--	
					9,076	

A-5

Benefits Upper Clark Fork Winter--Log-linear (includes VARØ3, VARØ4)

County/Area	Distance	Population	Benefits at max
Deer Lodge	8	13,900	3,328
Powell	18	7,600	933
Silver Bow	22	39,800	4,093
Granite	37	2,800	173
Lewis & Clark	74	41,000	1,034
Madison	84	5,400	109
Gallatin Area	104	51,200	649
Lake Area	132	88,000	482
Cascade Area	163	86,400	--
			10,801

A-6

Flint Creek Benefits--Log-linear on TC

County/Area	Distance	Population	Benefits at max	Benefits at 150
Granite	5	2,800	3,095	2,922
Deer Lodge	24	13,900	5,526	4,674
Silver Bow	50	39,800	8,854	6,428
Powell	50	7,600	1,692	1,227
Jefferson	77	7,600	1,121	656
Ravalli	78	21,100	3,069	1,776
Missoula	79	69,700	10,010	5,720
Lewis & Clark	98	41,000	4,617	2,106
Beaverhead Area	100	8,600	945	423
Lake Area	145	30,600	1,982	113
Cascade Area	187	152,800	5,910	--
Flathead Area	194	67,100	2,362	--
Choteau Area	229	30,600	621	--
Yellowstone Area	276	154,900	783	--
Hill Area	295	51,200	--	--
			50,587	26,045

A-7

Benefits Little Blackfoot--Semi-log (includes INC and SUB2)

County/Area	Distance	TC	Population	$e^{-.1548TC}$	Benefits Max
Elliston	3	.44	581	.934	288
Avon	12	1.77	581	.760	234
Lewis & Clark	24	3.54	41,000	.578	12,533
Deer Lodge City	35	5.17	5,845	.449	1,386
Jefferson	51	7.53	7,600	.312	1,246
Deer Lodge Area	65	9.60	16,700	.226	1,979
Silver Bow	75	11.07	39,800	.180	3,742
Missoula	91	13.44	70,300	.125	4,540
Cascade Area	113	16.68	152,800	.076	5,866
Lake Area	157	23.18	30,600	.028	394
Flathead Area	172	25.40	67,100	.020	577
Fergus Area	212	31.30	30,600	.008	72
Blaine Area	226	33.37	51,200	.006	61
Yellowstone Area	248	36.62	154,900	.0035	--
					32,918

A-8

Warm Springs Creek Benefits--Log-linear on TC

County/Area	Distance	Population	Max Benefits	Benefits @150
Deer Lodge	10	13,900	1,355	
Silver Bow	37	39,800	1,507	
Lewis & Clark Area	92	48,600	28	
Missoula Area	93	72,500	--	
			2,890	

A-9

Rock Creek Benefits[1]--Log-linear on TC

County/Area	Distance	Population	Benefits Max	Benefits 250
Missoula	26	69,700	335,637	287,629
Granite	47	2,800	9,535	7,608
Ravalli	63	21,100	59,201	44,668
Powell	63	7,600	21,324	16,089
Mineral	83	3,800	8,728	6,111
Deer Lodge	87	13,900	30,837	21,263
Lake	93	18,300	38,449	25,845
Silver Bow	94	39,800	83,102	55,689
Lewis & Clark	98	41,000	32,398	54,158
Sanders	101	8,500	16,639	10,784
Jefferson	126	7,600	12,298	7,064
Flathead	141	50,000	72,428	37,989
Teton	145	6,700	9,443	4,828
Beaverhead	155	8,600	11,274	5,300
Madison	165	5,900	7,238	3,174
Gallatin	185	40,200	42,955	15,329
Park	211	13,100	11,760	2,773
Lincoln	216	17,100	14,877	3,173
Cascade Area	217	88,800	76,483	15,320
Pondera	227	7,200	5,803	866
Hill Area	265	41,400	25,662	--
Glacier	266	11,400	7,014	--
Judith Basin	277	16,400	9,321	--
Yellowstone Area	322	129,800	51,805	--
Big Horn Area	351	12,000	3,674	--
Rosebud/Valley	411	29,700	4,254	--
Miles City/W.Pt.	475	72,900	--	--
			1,052,139	625,660

1. Includes non-residents. Resident value at every origin is 52.4%.

APPENDIX B

Literature Review: The Travel Cost Model

This appendix summarizes in greater detail the basic assumptions and methods of the travel cost model as reported in the economics literature.

Basic Model:

The objective of the travel cost method is to estimate a structural demand equation for a given recreation site using the visit rates corresponding to varying travel costs or supply prices of the origin zones surrounding the site of interest (Clawson, 1965; Knetsch, 1963; Knetsch and Davis, 1966; Smith, 1975). The most widely accepted measure of the quantity of site services use is visits per capita (Smith, 1980). The demand function is generally estimated by regressing the visit rate for each zone on the independent variables hypothesized to affect demand, such as travel cost, income and other socio-economic characteristics, and some measure of the availability and cost of substitutes (such as the travel cost to the nearest similar area).

Once the demand equation is identified, the consumer surplus attributable to the site is calculated. The actual travel cost to each zone is the lower limit of integration and the highest travel cost in the sample is the upper limit. This summed area under the demand curve plus any use fees on site provide the annual recreation benefit estimate. This model was initially developed and applied by Clawson (1965) and Knetsch (1963), following Hotelling's seminal idea (1949). Since these studies, the major advancement of the basic model has been to establish the role of time (Cesario and Knetsch, 1970; Cesario, 1976). Earlier formulations ommitted the opportunity cost of time in unit travel cost, which of course results in a downward bias to the estimate. Other theoretical contributions have been to establish that travel cost demand is a derived demand arising from a household's production of recreation services (Deyak and Smith, '78) and to develop a multi-equation regional application of the model (Cicchetti, et al, 1976, Burt and Brewer, 1971, and Cesario and Knetsch, 1976). There has also been substantial work for the various measures (compensation and equivalent variations) of consumer surplus. However, most of the studies reported in the literature are case applications, concerned primarily with exploring the interaction of data limitations and model assumptions (Capel, 1973; Davidson, 1966; Merewitz, 1966). For example, the prevalence of multiple destination trips or the true socioeconomic characteristics of users is generally not known. The empirical studies have also, of course, explored alternative model specifications.

In the following sections, the literature is briefly reviewed, with an eye toward guiding future applications. Assumptions and data, and model specifications will each be briefly examined.

Assumptions and Data

The basic idea behind the travel cost model is that travel cost is the supply price which rations use of the site in question. The cross-sectional sample by zone or origin identifies the quantity demanded of recreational services (visits) at alternative supply prices (travel costs). The model is clearly inapplicable in cases where there is not sufficient variation in supply price to trace out the demand curve (Smith, 1975) or where travel cost does not appear to be the dominant rationing mechanism (as for urban parks). In addition, the model as typically applied requires the following stringent assumptions:

(1) There is homogeneity across trips.

(2) Visitors have economic and demographic characteristics in conformity with those for all in their origin zone.

(3) Substitutes are identified and correctly modeled.

(4) The mode of travel and travel costs are the same across zone to permit convenient estimation of unit costs of travel for each distance level.

(5) The opportunity cost of time is known and it is reasonably constant across visitors.

In practice, the most problematic of these assumptions is the first. The likelihood that each trip is the same, a single purpose journey to the site in question, becomes increasingly unlikely for more distant zones (the problem of multiple destinations). Also, single visits as the measure of services demanded may be unreliable if there is great variation in the amount of time on site. One solution is to rely on more detailed survey data which provides individual observations of time at site, the opportunity cost of time, multiple destinations, and evaluation and use of substitutes. Another approach, suggested by Smith (1980) is to statistically identify the spatial limits to the model when limited secondary data is being used. He notes that the prevalence of multiple destination trips, longer time on site, and variance of unit travel costs are all probably a positive function of distance. He applies a test (originally developed for examining the properties of squared residence for progressive estimates over time) to progressive estimates over distance zones for the Ventana Wilderness in California. His conclusion was that a significant change in his estimated demand relationship occurs at 672 miles. Restricting the sample to this distance significantly reduces average consumer surplus per trip from $14.80 to $5.28 for a log-linear relationship.

<u>Specification</u>

The basic tradeoff in the specification of a set of demand equations for recreation analysis is between accurately estimating use and providing theoretically correct measures of benefits.

The most frequently adopted approach (Clawson and Knetsch, 1966; Smith, 1980; and others cited in Appendix B) is to use a separate demand equation for each site of interest. The area under this demand curve (consumers surplus) is a valid measure of benefits for the given site, providing that the function correctly incorporates all other relevant explanatory variables such as the price and

and availability of substitutes, income, etc. A multi-site model for baseline economic analysis can be constructed through a multi-equation set of these demand functions. In general the finding has been that a semi-log or a log-linear specification provides the best fit (Smith, 1980; 1975). However, in order for this approach to provide a uniquely determined measure of consumer surplus when many prices (travel costs, in this multi-site situation) are changing simultaneously, it is necessary that the "integrability condition" (Hotelling, 1938; Mishan, 1981) be satisfied. For the multi-equation model, this condition means that generally the price of all competing sites in the region will be included (as substitutes) in the demand function for any given site, and the condition requires that all cross price terms be symmetric, or:

$$\frac{\alpha\, v_{ij}}{\alpha\, TC_{ik}} = \frac{\alpha\, v_{ik}}{\alpha\, TC_{ij}}$$

where:

TC_{ik} = the travel cost from origin i to site k

v_{ik} = the visit rate from origin i to site k

However, in order to satisfy the symmetry condition, a linear specification of the model is almost a necessity. As a result, there is some conflict with the empirical validity of the model in terms of characterizing actual use, since in fact the underlying demand relationship appears to be curvilinear. There have been two applications of this constrained model in the literature (Burt and Brewer, 1971 and Cicchetti et al 1976). In both cases, the motivation was to provide a model that could provide theoretically correct benefit estimates in cases where many prices were in fact changing simultaneously. Specfcally, both cases were for evaluation of the introduction of a new site into already existing recreational areas: new Corps of Engineer Lakes in Missouri in one case and the proposed Mineral King ski area in Southern California in the other. A potential problem in this simultaneous equation approach, in addition to the linear specification, is that there may be a high proportion of zero values in the dependent variable, leading to heteroskedasticity in the estimates. (In other words, there may not be sample values for visits between all origin-destination pairs.) This would be a major problem in application of this constrained demand model to the Upper Clark Fork region. The total number of origins represented in the sample is 27; since many sites only showed visits from seven areas [Table 4, above] and one site [Warm Springs Creek] only four, it can be shown that there would be 58% zero values in the dependent variable. Excluding Rock Creek, the sample would still be troublesome for a simultaneous equation approach, with around 40% zero values.

To summarize, the multi-equation constrained set of demand functions was not the approach taken in this study for the following reasons: because of the poor fit found with a linear specification (as reported above), because of the limited sample, and because the purpose of this analysis is to provide a baseline analysis (rather than estimate benefits to new sites, or improvements in existing).

It is interesting to note an alternative is the gravity model, described by Cesario and Knetsch (1976). In order to get around the problem of symmetric cross price terms, they simplify matters considerably with a single equation model that has the <u>same</u> cross-price elasticity for all areas. The implicit assumption is that the substitution effect between all areas is identical; in addition, their model assumes that the response of the visit rate to any given site to changes in travel cost to that site (own price elasticity) is also the same for all sites and origin points. In order to still provide a reasonable representation of actual use (with these simplifications to a single equation model for a number of differing sites), the gravity model generally incorporates an "attractiveness" variable to account for differences in visitation among areas. This imposes an additional problem of correctly identifying the "attribute" measure and gathering relevant data. A positive feature of the model is that the basic function is curvilinear; unfortunately, there is no simple transformation which renders the model linear in parameters. As a result, complicated search routines must be employed to estimate parameters. Because conventional linear least-squares multiple regression techniques are not used, it is difficult to test the significance of estimated parameters.

As discussed in the last section of this paper (suggestions for further research), it would be of interest to do a comparative application of the constrained demand model and the gravity model to the Upper Clark Fork. Such an undertaking would be informative for the analysis of such things as the impact of water quality changes or site or route improvement on recreation benefits. Either of these approaches is beyond the resources and available data of the present study. For the purpose of baseline economic analysis, where the emphasis is necessarily on an accurate characterization of use (with a sacrifice of flexibility in benefit estimations), a multi-equation model of unrestrained demand equations has been applied.

Three alternative specifications commonly employed in travel cost studies are linear (equation 1), log-linear (equation 2) and semi-log (equation 3):

$$(1) \quad V = a + b_1.TC + b_2.Y + b_3.TC_s + b_4.A + b_5.Ed$$

$$(2) \quad \ln V = a + b, \ln TC + b_2 \quad \ln Y \; tb_3 \; \ln TCS + b_4 \ln A + b_5 \ln Ed$$

$$(3) \quad \ln V = a + b_1 TC + b_2 \; Y = b_3 TC_s + b_4 A + b_5 \; Ed$$

where:

a, b_{1--n}	parameters to be estimated
V	visit rate per capita
TC	travel cost to site from zone of origin
Y	income measure for zone of origin (median family income, % below $5,000, etc.)
TCS	travel cost to a similar area (substitute)
A	median age for zone or origin
ED	median years of education for zone of origin

In general, the literature reports that the linear formulation provides an inadequate fit (based on conventional statistical tests such as $\bar{R}^2$ and the t-statistics on estimated parameters). While both log-linear and semi-log provide good fits, there is no theoretical basis or strong empirical evidence to choose between them. Smith (1980) did find that the semi-log formation did not demonstrate spatial limits, while the double-log formulation did. Possibly this is due to the variable elasticity of the semi-log model.

APPENDIX C

Regression Estimates

VARØ2, VARØ3, VARØ4 refer to travel cost, income, and a measure of substitute availability as reported in the main paper. The values in parenthesis below the regression coefficients are the t statistic. Given the poor fit of the linear models, all parameters are not reported for this particular specification.

C-1

Lower Clark Fork - Summer

Equation(n)	Constant	VARØ2	VARØ3	VARØ4	$\bar{r}^2$	F
Linear (16)		-(80%)			.081	2.33
		-(90%)	+(80%)		.171	2.55
		-(90%)	+(80%)		.153	1.90
Semi-log (16)	-2.299	-.141			.635	27.06
		(5.20)				
	-5.778	-.1496	+.0006		.673	16.42
		(5.71)	(1.62)			
	-5.064	-.152	+.0006	-.021	.687	11.97
		(5.92)	(1.78)	(1.26)		
Log-linear (16)	-.810	-1.598			.851	87.02
		(9.33)				
	7.764	-1.617	-.975		.845	41.93
		(9.13)	(.65)			
	7.320	-1.626	-.972	+.1167	.833	25.91
		(8.61)	(.62)	(.21)		

C-2

Lower Clark Fork - Winter

Equation(n)	Constant	VARØ2	VARØ3	VARØ4	$\bar{r}^2$	F
Semi-log (7)	-1.612	-.161			.846	34.00
		(5.83)				
	-2.132	-.161	.0001		.809	13.67
		(5.18)	(.13)			
	-1.644	-153	.0001	.021	.761	7.35
		(3.92)	(.14)	(.44)		
Log-linear (7)	-.313	-1.651			.743	18.37
		(4.29)				
	+40.56	-1.797	-4.599		.745	9.75
		(4.38)	(1.01)			
	41.91	-1.647	-4.068	-1.83	.805	9.24
		(4.42)	(1.02)	(1.49)		

C-3

Middle Clark Fork - Summer

Equation(n)[7]	Constant	VARØ2	VARØ3	VARØ4	$\bar{r}^2$	F
Linear					.419	5.32
					.446	3.41
					.510	3.07
Semi-log	-1.906	-.243			.605	10.19
	-5.217	-.2088	-.0011		.636	6.25
		(2.66)	(1.20)			
	-5.304	-.2022	-.0011	.0042	.518	3.15
		(1.96)	(1.01)	(.13)		
Log-linear	-2.439	-1.071			.593	9.73
		(3.12)				
	37.66	-.933	-4.566		.528	4.36
		(2.10)	(.56)			
	34.51	-.978	-4.079	-2.79	.376	2.21
		(1.69)	(.416)	(.167)		

C-4

Middle Clark Fork - Winter

Equation(n)	Constant	VARØ2	VARØ3	VARØ4	$\bar{r}^2$	F
Semi-log (7)	-2.549	-.148			.700	15.03
		(3.88)				
	3.940	-.130	-.001		.653	6.64
		(2.57)	(.56)			
	-31.29	-.168	.0036	.094	.818	9.99
		(4.02)	(1.45)	(2.15)		
	-4.707	-.1285		+.0396	.768	10.93
		(3.58)		(1.57)		
Log-linear	-1.771	-1.347			.522	7.55
		(2.75)				
	27.69	-1.228	-3.372		.407	3.056
		(1.34)	(.17)			
	-318.8	-2.064	+34.52	+3.78	.367	2.16
		(1.55)	(.71)	(.87)		

C-5

Upper Clark Fork - Summer

Equation(n)	Constant	VARØ2	VARØ3	VARØ4	$\bar{r}^2$	F
Linear (7)					.25	3.01
					.09	1.30
					.04	.91
Semi-log (7)	-2.946	-.191			.830	30.28
		(5.50)				
	-1.187	-.1808	-.0003		.801	13.05
		(4.30)	(.52)			
	-2.228	-.1643	-.0002	+.008	.781	8.11
		(3.37)	(.39)	(.79)		
Log-linear	-1.678	-1.625			.969	188.21
		(13.72)				
	-7.940	-1.661	.715		.962	78.83
		(10.76)	(.43)			
	-11.092	-1.557	+.891	+.349	.978	88.01
		(11.79)	(.684)	(1.90)		

C-6

Upper Clark Fork - Winter

Equation(n)	Constant	VARØ2	VARØ3	VARØ4	$\bar{r}^2$	F
Semi-log (9)	-2.034	-.182			.82	38.63
		(6.22)				
	-2.838	.176	-.0007		.88	31.00
		(7.29)	(2.11)			
	-2.842	-.157	.0009	.0103	.88	20.94
		(5.06)	(2.32)	(.99)		
Log-linear (9)	-.105	-1.987			.844	44.42
		(6.66)				
	49.37	-1.955	-5.636		.931	55.23
		(9.85)	(3.14)			
	57.60	-1.677	-7.019	.843	.969	86.19
		(10.33)	(5.47)	(2.93)		

C-7

Flint Creek

Equation(n)	Constant	VARØ2	VARØ3	VARØ4	$\bar{r}^2$	F
Linear (15)		-(sig)			.168	3.83
		-(sig)			.099	1.77
		-(sig)		+(sig)	.253	2.58
Semi-log (15)	-2.454	-.110			.637	25.61
		(5.06)				
	-2.998	-.112	+.0001		.609	11.91
		(4.67)	(.25)			
	-3.029	-.1195	+.0000	+.0118	.655	9.87
		(5.20)	(.00)	(1.61)		
Log-linear	-.564	-1.537			.797	55.96
		(7.48)				
	.700	-1.532	-.145		.780	25.85
		(6.97)	(.09)			
	.109	-1.543	-.3051	-.0884	.761	15.89
		(6.59)	(0.0)	(.23)		

C-8

Little Blackfoot

Equation(n)	Constant	VARØ2	VARØ3	VARØ4	$\bar{r}^2$	F
Linear (14)		-(sig)			.355	8.15
		-(sig)	+(80%)		.412	5.55
		-(sig)		+(sig)	.566	6.65
Semi-log (14)	-2.349	-.1536			.710	32.81
		(5.73)	(80%)			
	-6.36	-.160	+.0006		.749	20.38
		(6.34)	(1.69)			
	-6.011	-.1591	+.0004	+.0131	.813	19.80
		(7.29)	(1.30)	(2.18)		
	-3.393	-.1548		+.0152	.801	27.16
		(6.96)		(2.54)		
Log-linear (14)	-1.181	-1.578			.798	52.33
		(7.23)				
	-17.90	-1.585	+1.902		.797	26.45
		(7.24)	(.96)			
	-11.61	-1.616	+2.181	-1.658	.779	16.25
		(6.56)	.198)	(.33)		