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Environmental Trade-Offs in the Lower Sheyenne Valley

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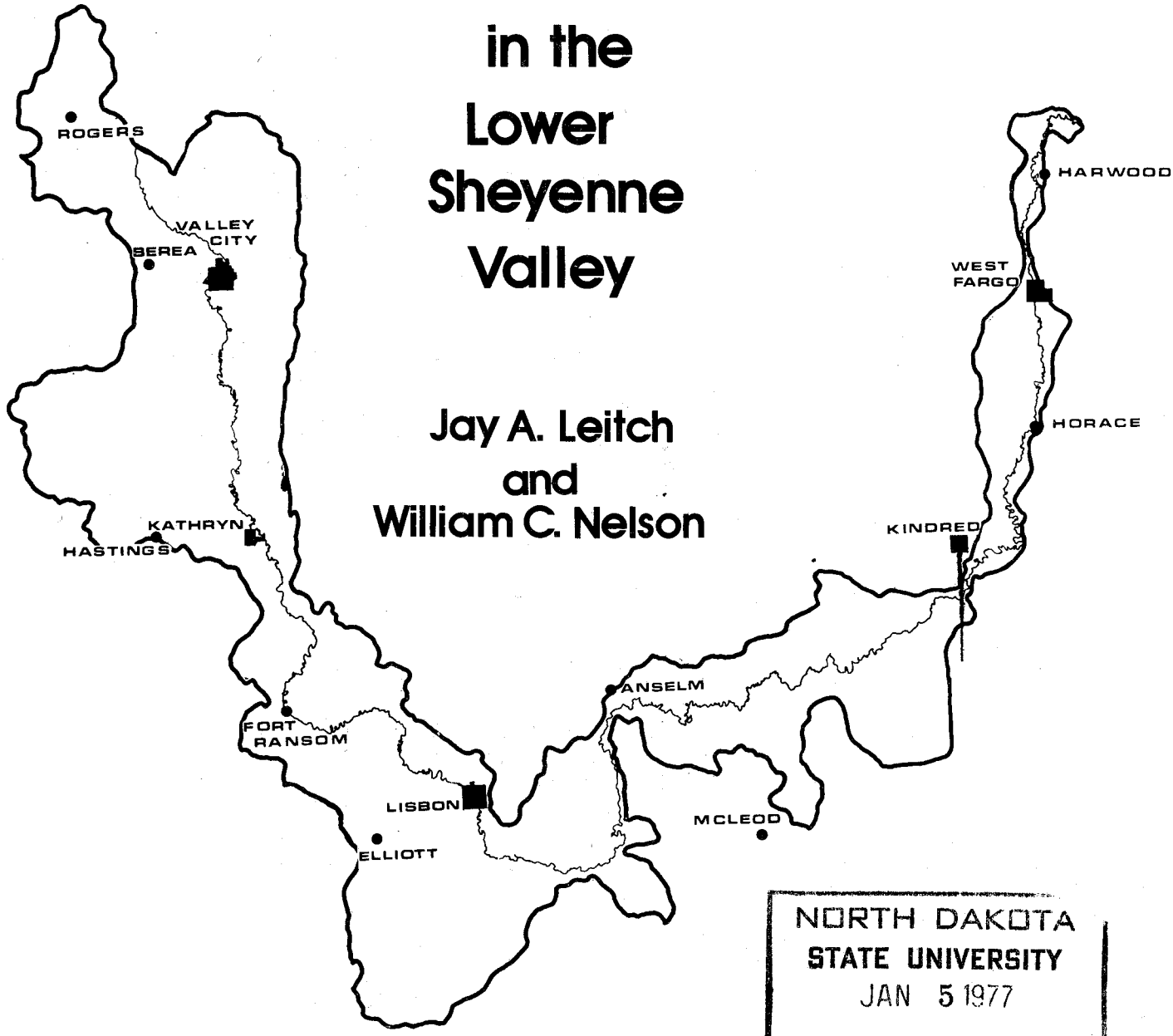

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FOREWORD

Environmental issues are a major part of natural resource decisions. They frequently are discussed solely on an emotional level due to the paucity of information. The authors believe the technique used in this study and its results will help to alleviate this problem.

We extend our appreciation to the following persons for their comments and information:

Donald Scott, Assistant Professor, Agricultural Economics, North Dakota State University.

George Pfeiffer, Research Associate, Agricultural Economics, North Dakota State University.

James Grier, Assistant Professor, Zoology, North Dakota State University.

William Barker, Associate Professor, Botany, North Dakota State University.

Larry Falk, Chairman, Sociology, Concordia College.

The research for this report was part of a project on land use and water quality in the Lower Sheyenne River Basin. The research is being conducted by a multidisciplinary team composed of William C. Nelson, Agricultural Economics; William T. Barker, Botany; Mary C. Bromel, Bacteriology; John A. Brophy, Geology; Delmer L. Helgeson, Agricultural Economics; and William D. MacKeller, Chemistry. The research was supported with funds from:

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HIGHLIGHTS

The priority evaluator technique (PET) was used to estimate preferences of Sheyenne Valley residents toward: (1) scenic view; (2) water recreation; (3) floods; (4) wildlife habitat; and (5) land recreation. PET involved three levels of each of the five environmental categories, prices of each level, a limited budget, and a requirement to purchase one level of each of the five categories.

Respondents purchased a set of environmental attributes which includes a higher level of flood protection and water recreation than currently exists in the valley. They decreased the level of scenic view and land recreation while maintaining wildlife habitat at a level approximately equal to existing level.

ENVIRONMENTAL TRADE-OFFS IN THE LOWER SHEYENNE VALLEY

by

Jay A. Leitch and William C. Nelson*

I. INTRODUCTION

Environmental factors are becoming an increasingly important aspect of natural resource decisions. The market determines value of goods and services which are bought and sold, but items such as scenic sites and wildlife habitat are rarely valued through the market place. For example, the costs of floods and, therefore, the value of flood control can be estimated in monetary terms, but scenic sites and wildlife habitat which might be destroyed by a reservoir are extremely difficult to value in monetary terms. This problem frequently leads to undervaluing environmental factors in analyses of natural resource projects and to sharp conflicts between proponents and opponents of a project.

Objectives

The major objective of this research was to estimate the preferences of Sheyenne Valley residents toward five environmental attributes: (1) scenic view; (2) wildlife habitat; (3) frequency of floods; (4) water based recreation; and (5) land recreation. The secondary objective was to evaluate the capability of the priority evaluator technique (PET) to provide reasonable estimates of preferences under conditions of limited budgets.

Study Area

Because of the periodic threat of floods to Fargo, West Fargo, and other downstream areas, the North Dakota State Water Commission requested the Army Corps of Engineers conduct a feasibility study of flood control measures on the Lower Sheyenne River between West Fargo and Valley City in 1961. The Corps (Army Corps of Engineers, 1968) concluded that a 75-foot high dam,

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six miles southwest of Kindred, North Dakota (Figure 1), was the best alternative--the one with the best benefit/cost ratio. Opposition arose to the proposed dam due to the unique topography of the area to be inundated and prevented its construction.

Renewed interest was shown in constructing some sort of flood control device following the floods in 1969 and 1975. Renewed opposition to a dam also has arisen from environmental groups and ranchers residing in the area of the proposed reservoir. The main focus of the environmental group opposition is the destruction by the reservoir of a large area of river gallery forest which provides wildlife habitat and land based recreation.

Forty-six percent of 135 500 acres of land in the Sheyenne Valley from Kindred to Anselm is being cultivated, the remainder is in woodland (10 percent), wetland (3 percent), or grazing land (41 percent). It is the least densely populated part of the Lower Sheyenne Valley, with many sections (one square mile) having no human inhabitants. The savanna vegetation of the grasslands and the associated gallery forest of the river banks combine to make this one of the richest areas of wildlife habitat in eastern North Dakota. It harbors a relative abundance of wildlife and possesses the potential for more. "Development of this potential rests primarily in the hands of private landowners to initiate land use practices which will enhance wildlife habitat" (Vollink, 1975: 36).

The Sheyenne National Grasslands constitute approximately 20 percent of this area. They are administered by the U.S. Forest Service and leased for grazing. Mirror Pool Game Management Area (546 acres), owned and operated by the North Dakota State Game and Fish Department, provides habitat for several wildlife species. There are 28,844 acres of publicly owned recreation land in this region (Table 1).

TABLE 1. PUBLIC WILDLIFE AREAS IN THE LOWER SHEYENNE VALLEY INCLUDING REFUGES

Subdivision	Acres of Public Hunting	Wildlife Refuges	Total
Lake Agassiz	0	0	0
Sheyenne Delta	28,844	0	28,844
Drift Prairie	3,392	2,480	5,872
	31,236	2,480	34,716

SOURCE: Morgan, Robert, North Dakota Game and Fish Department; James C. Gritman, USDI, Fish and Wildlife Service; and County Atlas.

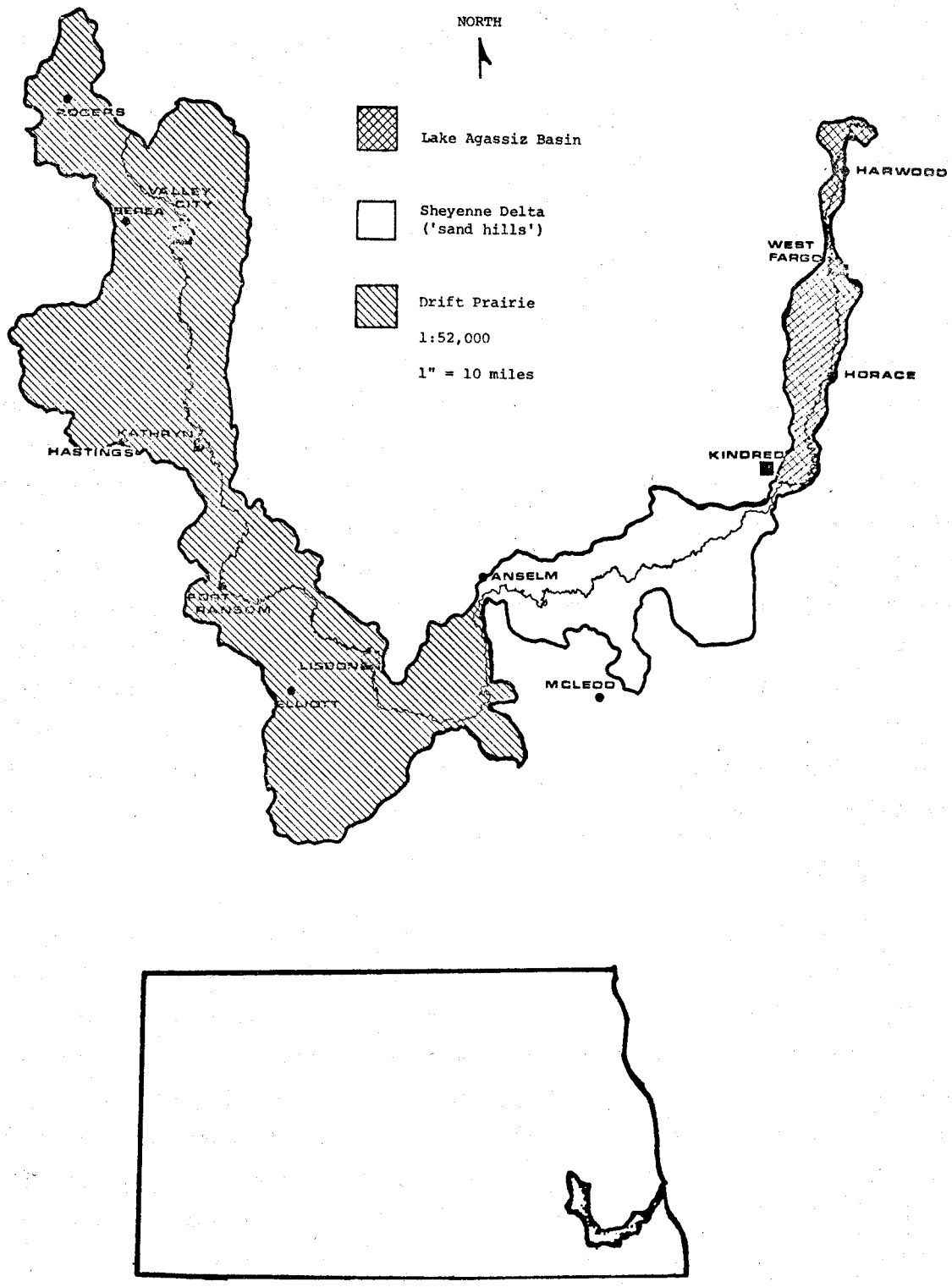


Figure 1. Lower Sheyenne Valley: Physiographic Regions

The Sheyenne Delta provides many hours of sport-hunting. Whitetail deer are probably the single most sought after game species in the delta. The delta has a herd of approximately 1,500 deer and is the wintering area for deer from the surrounding agricultural land. In addition to deer hunting, the delta supports large numbers of squirrels and upland game birds. Waterfowl hunting is provided by migrating waterfowl, augmented by local birds. Fox hunting also is pursued in this section of the Valley. Walcott, North Dakota, located just outside the Valley, claims to be the "Fox Capitol of North Dakota." As in the rest of the Sheyenne Valley, there is a variety of nongame wildlife in the delta area that provide enjoyment to recreationists.

An isolated habitat for fauna has developed here as a result of the unique grassland ecosystem. At least three species of birds--barred owl, pileated woodpecker, and cerulean warbler--are not known to occur elsewhere in North Dakota. Six others classified as very rare in North Dakota--scarlet tanager, yellow-billed cuckoo, yellow-bellied sapsucker, yellow-throated vireo, green heron, and the American woodcock--also exist in the delta region. Four nongame animal species, rare in North Dakota, are found here. They are the gray fox, Eastern chipmunk, Northern flying squirrel, and woodland deer mouse. The wood frog and the redsided garter snake are found only in this particular part of the state (Cann, 1971).

II. PRIORITY EVALUATOR TECHNIQUE

The priority evaluator technique (PET) developed by Social and Community Planning Research, London, England (Hoinville, 1971), was used by Pendse and Wyckoff in evaluating the impact of a new dam in the Willamette Basin, Oregon. (1974a, 1974b). A simulated market experiment based on the priority evaluator technique was the basic tool of analysis. Each respondent was given a limited budget and asked to purchase a package of several environmental situations. "The act of selecting the mix of situations that maximized respondents' satisfaction established the relative value of different situations" (Pendse and Wyckoff, 1974a: 6). The technique only gave relative values, but did yield an indication of the willingness of the respondents to make trade-offs within the system. Pendse and Wyckoff conclude by saying:

> The strength of the methodology reported here lies in its capability to approximate the environmental values and indicated trade-offs for different aspects of the natural

> environment. It can be useful in (a) charting the direction and magnitude of changes sought by people, (b) identifying preferences for different aspects of the environment, and (c) providing guidelines for restoring and protecting aesthetic and scenic aspects of the environment. (1974a: 16)

A potential use of this technique to evaluate wildlife resources is to offer some choices with known economic values. For instance, the economic value of flood control could be calculated in the Willamette study. One could then infer the dollar values of other choices which did not have readily discernable economic value by using the trade-off ratios between flood control and the other choices.

The priority evaluator technique was also used by Pendse and Wyckoff to examine priorities on the Oregon State University campus regarding traffic (Pendse and Wyckoff, 1974c). They claimed that PET simulates the marketplace and allowed the respondent to evaluate alternative environments within a fixed cost framework. The only constraints in this allocation process were that the respondent could purchase only one alternative from each environmental situation, he must spend the entire budget, and he could not overspend.

One measure of value of a good or service is the utility sacrificed in the best alternative use of the individual's time and budget. This best alternative differs among people and with the same person depending upon the situation. The methodology of this model relies on traditional economic principles for allocation of limited resources among competing and costed alternatives. PET permits respondents to evaluate present conditions and allows them to choose a set of alternatives that will provide maximum satisfaction.

> The PET, through its simulated game plans, can provide information on: (1) respondents' preferences with respect to environmental goods; (2) the relative value that people attach to environmental goods; (3) the direction and magnitude of changes preferred; and (4) the trade-off values of environmental goods. (Pendse and Wyckoff, 1974a: 4).

The PET allows respondents alternative solutions and mixes of goods. It requires them to sacrifice in one or more areas if they intend to have a high level of another variable.

Assumptions of the PET are (Pendse and Wyckoff, 1974a):

1. Each individual prefers the environment that provides the individual or the community the most satisfaction. (In other words, no further trade-offs can be made without making someone worse off.)

2. The different levels of each situation are given. The prices of each level of the environmental variables are fixed. The respondent cannot choose to buy more or less than is offered by the matrix of alternatives.
3. Each choice of a category provides some level of nonnegative satisfaction.
4. Each choice is independent of the other(s) and can be traded for them. For instance, when a respondent bought "almost no threat of flooding" he was not assured of a large dam, which would provide the highest level of water recreation. Subsequently, if "a lot" of water recreation was purchased, that choice assured neither flood protection nor took away any possible choices of the other variables, except choices eliminated by the budget constraints.
5. Allocation of a given budget among alternative situations is optimum when the individual cannot increase his satisfaction by further trades.

Constraints of the model are:

1. Only one choice may be made in each environmental category in the optimum allocation and one choice must be made.
2. The value of optimum composite of choices cannot exceed the given budget level, although it may be less.

Given the above assumptions and constraints, the PET simulates the marketplace and allows the respondent to evaluate alternative environmental situations within a fixed cost framework. The respondent, by choosing the combination of goods that pleases him most, shows the trade-offs he is willing to make between environmental goods.

The economic concept of indifference analysis is similar to the PET technique. A list of goods could be presented to the respondent. He is asked to array this list of goods in order of his preference for them and indicate trade-offs he would be willing to make among the goods. Included in the list would be those with and those without dollar prices. From the array the researcher could infer prices to the unknowns.

Basic Model

A gaming technique, the priority evaluator technique (PET), patterned after the Pendse and Wyckoff applications (1974a, 1974b, and 1974c), was used

to determine trade-off values of wildlife habitat and several environmental alternatives in one part of the Sheyenne Valley. The Kindred Dam area was chosen, using flood control as one component of the model.

The priority evaluator technique was adopted for this study in an effort to circumvent a potential bias regarding the focus of the study's wildlife values. Biased responses can frequently occur in single subject attitude surveys due to question design and respondent empathy. The PET directed respondent's attention to a set of environmental attributes and not directly to wildlife (Figure 2). A truer picture of the relative value of wildlife was expected to be obtained with this approach.

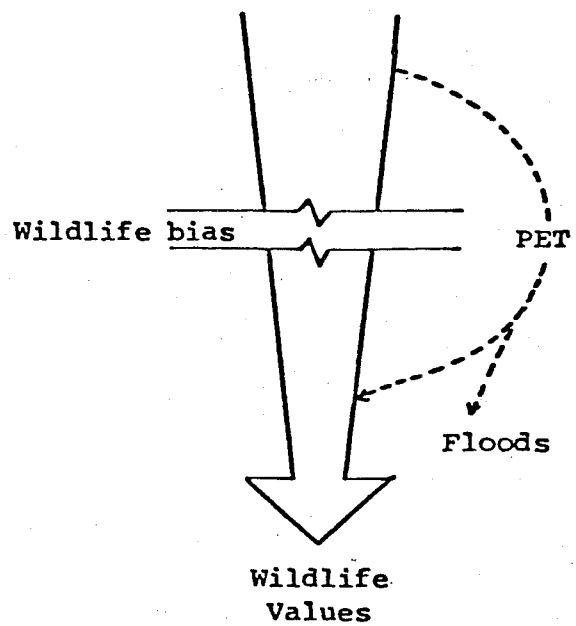


Figure 2. Advantage of the Priority Evaluator Technique

A set of photographs was developed to depict various levels of development for each of five environmental variables--scenic view, water recreation, floods, wildlife habitat, and land recreation (Figure 3). A uniform explanation of each group of environmental variables was given to the respondents (Appendix A). From the set of photographs, respondents were asked to complete the following tasks: first, identify the scenes which they thought best represented the existing situation in the dam/reservoir area from each column in Figure 3; second, to purchase a level of each variable using the prices given below each picture with a budget of $32; and third, to purchase a level of each

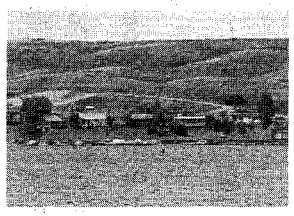
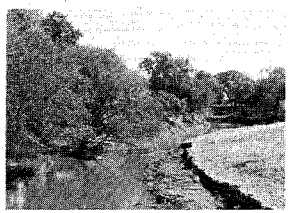
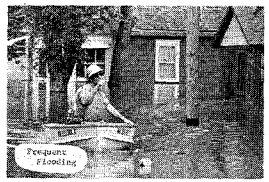
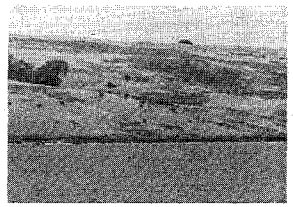
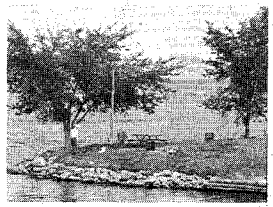
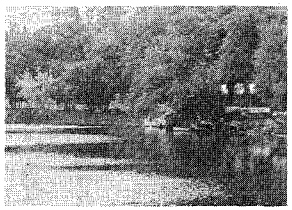
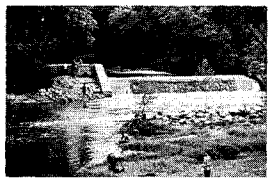
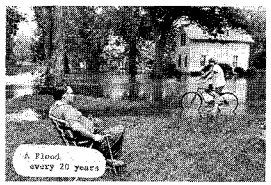
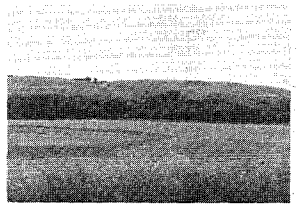
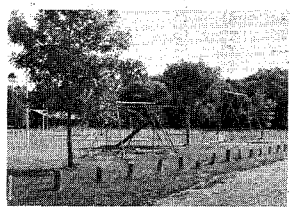
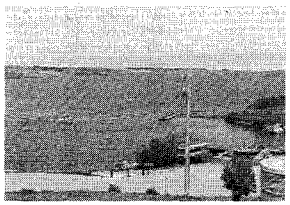
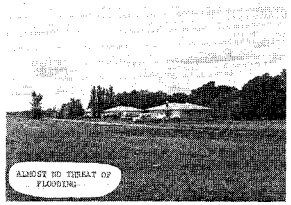
SCENIC VIEW	WATER RECREATION	FLOODS	WILDLIFE HABITAT	LAND RECREATION
 1	 1	 1	 1	 1
 3	 3	 7	 2	 2
7	 8	 18	5	5

FIGURE 3. ENVIRONMENTAL VARIABLES

variable using a budget of $25. Socioeconomic data also were collected on the PET questionnaire.

Budget and Price Estimation

Previous use of the PET is quite limited. Hoinville (1971) discussed using "crude supply costs" as the price of each variable. Pendse and Wyckoff (1974a) used the "approximate cost of supplying or maintaining the particular standard" to price each variable. They used the "...annual cost of maintaining and improving the quality of environment..." They argued "in effect, the cost of supplying environmental goods of specific quality was assumed to represent their prices" (Pendse and Wyckoff, 1974a: 78).

In this study the cost of flood control for "almost no threat of flooding" was estimated to be $18 million in 1974 dollars (Corps of Engineers, 1968: 69). This is the cost of a dam for the single purpose of flood control and does not include any additional costs for fish and wildlife or recreation.

The price of water-based recreation was estimated at $8 million for the provision of the amount that would be present with a large reservoir. The Corps of Engineers' single purpose cost estimate for recreation, including fish and wildlife, was $10 million in 1968. Because no better means of pricing was available, half of that figure, $5 million, was arbitrarily chosen to represent water recreation and adjustment to 1974 dollars yielded an $8 million estimate.

Land-based recreation was estimated to cost $5 million for the situation offering the highest level. This figure was chosen as the cost of providing facilities of camping and land-based recreation for an area equal in size to the proposed reservoir. The area is not presently used intensively for this purpose. Five million dollars is likely a conservative estimate. For example, Douglas (1963) calculated the cost of campsites at $1,200 each. The Bureau of Reclamation (Douglas, 1963) calculated the cost of a single campsite at $1,654. One thousand campsites, alone, would cost between $1.2 and $1.6 million in 1963 dollars. With the addition of hiking trails, roads, picnic facilities, tree plantings, and other costs, the price of camping and recreation would equal or exceed the estimated cost of $5 million.

The provision of wildlife habitat was estimated to cost $5 million This figure was estimated as the cost to prepare and maintain 2,750 acres of woodland habitat and 2,750 acres of prairie or grassland habitat--about what would be inundated by the proposed Kindred Reservior. Costs were computed using North Dakota State Game and Fish Department estimates for providing the necessary fences, roads, land acquisition, tree planting, and other investment and maintenance costs.

The scenic view category was the most difficult to price. The price chosen was one and one-half times as much as the provision of wildlife habitat, or $7.5 million, rounded to $7 million to be workable in the game. The rationale for this decision was the probability of additional costs in maintaining a scenic landscape with the development of road networks and other man-made intrusions on the landscape.

The prices assigned each variable had to meet two basic qualifications: first, they had to be expressed in fairly small round figures to be workable in application of the game; and, second, they had to be representative of the real differences in price both within and between alternatives. The low level (top row in Figure 3) of each variable was priced at $1 million, as it was assumed that some expense would be required to maintain this level. The intermediate level was arbitrarily priced at approximately 35 percent of the cost of the highest priced situation because cost was assumed to increase disproportionally as the maximum situation is approached.

Budgets for playing the game were set at $32 and $25. The $32 budget would allow respondents to choose from a field of 214 possible combinations of one situation from each environmental variable, but would not allow them to buy the highest priced situation in each variable simultaneously. The $25 budget, set to see what respondents would sacrifice from the higher budget, allowed a choice of 162 combinations. There were 243 possible combinations with no budget constraints.

Sampling Methods

The sample consisted of three groups of respondents. The first group was those persons whose land would be inundated by the proposed dam and reservoir. The population in this case is about 50 households. The sample size chosen was 20 households.

The second group of respondents was those who reside in the immediate area of the dam and reservoir, but whose property would not be inundated. This group included the residents of Leonard, Walcott, and rural areas. The population of this group depends on the definition of immediate area, but for this study the population was about 750 households. The sample size of 30 was made up of 15 urban and 15 rural households.

The third sample group was those who reside downstream from the proposed dam and who would benefit from flood protection. Twenty residents of West Fargo, five residents of Kindred, and five rural residents were selected for this group of 30 respondents. The population of this sample group is about 10,000 persons or 3,000 households.

The sample for each group was chosen by dividing urban areas into city blocks and numbering them. A sample of blocks was then drawn through application of a standard table of random numbers. Households were contacted in the blocks in numbered sequence until the desired number of responses was obtained. No provision was made for return calls to those households where no one was at home.

Rural residents were sampled in a similar manner with townships being numbered and selected through application of a standard table of random numbers. The northeast quarter of the township was surveyed until all households were contacted or 5 responses were obtained. Again, no provision was made for follow-ups if no one was at home.

The group of respondents whose land would be inundated by the dam and reservoir was not selected randomly. Instead, those living along the river were contacted until the 20 desired responses had been obtained. Many of the 50 or so landowners in the area are absentee. Therefore, most of the permanent local residents were contacted in order to obtain the 20 desired responses. Socioeconomic characteristics of the sample are presented in Appendix B.

Chi-square tests of significance revealed a significant ($P<0.05$) difference between sample groups in the length of residence at their present location. The reservoir sample group had the longest length of residence with the adjacent group being next in longevity of residence. The occupation of the "chief breadwinner" in the family of each respondent was significantly different among the sample groups. The reservoir and adjacent group were similar, most being engaged in farming. There were only a few farm operators in the downstream group. No significent differences were found among sample groups with respect to other socioeconomic characteristics.

III. RESULTS

Purchases made by the respondents revealed their satisfaction or dissatisfaction with the existing situation. If they bought the same level as they believed currently existed, then they would have been completely satisfied with the existing situation. If they bought a different level, they were expressing dissatisfaction with what exists in the area. A satisfaction ratio (SR) was calculated as:

$$SR = \frac{\text{budget choice}}{\text{existing situation}}$$

If the SR was equal to or close to one, the respondents were satisfied with the existing situation. If, however, the SR was less than or greater than one, it would indicate that respondents preferred a different combination of alternatives than they believe exists in the Sheyenne Valley. Since one cannot say any specific level of any of the variables is more or less preferred, any move of the SR away from one represents dissatisfaction with the existing environment. It does not necessarily infer satisfaction or dissatisfaction with a single environmental attribute, but with the existing combination of attributes.

Scenic View

Respondents felt that the existing level of scenic view was somewhere between situations II and III. Given numerical values of one for situation I, two for situation II, and three for situation III, the mean value for existing scenic view was 2.47 (Table 2). Chi-square tests revealed no significant difference ($P<0.05$) in the way the three sample groups perceived the existing scenic view.

The combined respondents chose a level of 2.13 in the scenic view variable with the $32 budget. This resulted in a SR of .86 and showed either a dissatisfaction with the existing level of scenic view, or a trade-off in order to increase the level of another variable due to budget constraints.

A degree of scenic view was traded off with the $25 budget bringing the numerical average down to 1.91 for an SR of .77. This shows not necessarily an absolute level of dissatisfaction with scenic view as it exists, but rather may show a sacrifice of scenic view in an effort to raise the level of other variables given the budget restriction. All changes from the existing levels indicate relative degrees of dissatisfaction; that is, relative to the initial level of the variable, to the initial levels of all other variables, and to the budget constraint.

TABLE 2. SCENIC VIEW AVERAGE PET SCORE

Group	Scenic View Average "Score"				
	Existing Situation		$32 Budget		$25 Budget
Downstream	2.43		1.90		1.56
Adjacent	2.46		2.30		2.06
Reservoir	2.55	SR	2.25	SR	2.20
Mean	2.47	.86	2.13	.77	1.91

The direction and magnitude of net trade-offs between the existing situation and the $32 and $25 budgets show the net result of the combined moves made by the three groups of respondents (Table 3).

TABLE 3. NET TRADE-OFFS OF SCENIC VIEW

Conditions	Situations, Choices, and Trade-Offs		
	I	II	III
Existing to $32 Budget	11	20 ← 15 ←	49
	↑← 6	←	↓
$32 Budget to $25 Budget	17 ← 4 ←	35	28
	↑← 7	←	↓
Existing to $25 Budget	11	20 ← 11 ←	49
	↑← 17	←	↓

The numbers inside the first row of boxes in Table 3 represent the positions of respondents after the existing situation choice had been made. The arrows in the first row represent net moves made by respondents when presented with a $32 budget. The numbers inside the second row of boxes represent positions of respondents after choices had been made with the $32 budget. The arrows in this row represent net moves made by respondents when restricted by the $25 budget. The numbers inside the third row of boxes represent the positions of respondents after the initial choice. The arrows in this row represent how net moves with the $25 budget would look when compared with the initial choices of what respondents perceived as existing.

Net moves in the scenic view variable were in the direction of an environment that includes man as a major component. Situation I of scenic view (Figure 3) includes man as a major component of the environment, while situation III does not. A total of 6 persons went from situation III to

situation I in the move from the existing situation to that with a $32 budget, while 15 persons chose to go from situation III to situation II. The number choosing situation III went from 49 persons in the existing situation to 28 persons under the $32 budget, losing 21 (15 to situation II and 6 to situation I). Although the respondents may have wanted to purchase a higher level of scenic view, they chose to trade that variable for higher levels of some of the other variables. Budget constraints prevented respondents from buying a high level of every variable so a sacrifice had to be made in one or more variables.

Chi-square tests revealed no significant difference among sample groups in responses for scenic view with the $32 budget. With the $25 budget, however, there was a significant difference. The downstream respondents traded off more scenic view than did either the adjacent or reservoir residents. Each group perceived the existing level of scenic view to be about the same; however, the downstream residents, who were further removed from the area, appeared to be less concerned with maintaining the scenic view.

Water Recreation

The existing water recreation, as perceived by respondents, was between situations I and II, with a mean value of 1.31 (Table 4). Chi-square tests showed no significant difference in the way the three sample groups perceived existing water recreation.

Water recreation had a SR of 1.54 at the $32 budget and 1.33 at the $25 budget. One half of the respondents picked situation II of water recreation as the one most appealing to them. A part of scenic view given up may have been traded for a higher level of water recreation.

TABLE 4. WATER RECREATION AVERAGE PET SCORE

Group	Water Recreation Average "Score"				
	Existing Situation		$32 Budget		$25 Budget
Downstream	1.36		2.20		1.93
Adjacent	1.33		2.13		1.73
Reservoir	1.20	SR	1.65	SR	1.50
Mean	1.31	1.54	2.04	1.33	1.75

A significant difference in water recreation choices at $32 occurred among the sample groups but not at the $25 budget level. With the $32 budget, 50 percent of the reservoir residents preferred to remain at level I and 35 percent at level II. Only 13 percent and 16 percent, respectively, of the downstream and adjacent respondents chose to purchase level I of water recreation with the $32 budgets. The difference in responses could have been due to respondents from the reservior area relating situations II and III with the construction of a dam. Fifty-three percent of the downstream and adjacent respondents chose level II of water recreation. The average score for water recreation with the $32 budget was 2.04 (Table 4).

Moving from the existing condition to the $32 budget, the respondents made net moves toward the higher level of water recreation (Table 5). With the more restrictive $25 budget, respondents made net moves toward a lower level of water recreation than they had chosen with the $32 budget, but higher than the existing situation.

TABLE 5. NET TRADE-OFFS OF WATER RECREATION

Conditions	Situations, Choices, and Trade-Offs		
	I	II	III
Existing to $32 Budget	56 → 16 →	21 → 23	→ 1
$32 Budget to $25 Budget	19	39 ← 1 ← 11 ←	22
Existing to $25 Budget	56 → 17 →	9 → 23	→ 1

Floods

The existing flood situation was believed to be midway between situations I and II, with a mean value of 1.52 (Table 6). Respondents believed the Sheyenne River is prone to flooding less often than "frequently" (Situation I) but more often than "once in twenty years" (situation II). Chi-square tests showed a significant difference existed in the way sample groups perceived the flood situation. The downstream residents perceived the existing situation as flooding more frequently. The adjacent residents and reservoir area residents believed flooding would occur approximately every 20 years.

TABLE 6. FLOODS AVERAGE PET SCORE

Group	Floods Average "Score" Existing Situation		$32 Budget		$25 Budget
Downstream	1.36		2.93		2.53
Adjacent	1.46		2.67		2.33
Reservoir	1.85	SR	2.80	SR	2.30
Mean	1.52	1.84	2.80	1.57	2.40

The highest level of dissatisfaction for any variable was shown in the floods category. With a $32 budget, respondents bought a 2.8 average level of floods, for an SR of 1.84. They bought a 2.4 level of floods, for a SR of 1.57 with a $25 budget. Even though most respondents chose situation III as their desired level of floods with a $32 budget, some were willing to have a higher frequency of flooding under a $25 budget limitation rather than lower the level of the other four variables.

The net trade-offs for floods show respondents desired to better their flood protection with either budget. There was a move away from situation III in moving from the $32 budget to the more restrictive $25 budget (Table 7). The price of level III of floods forced too great sacrifices in other attributes for some of the respondents with the $25 budget.

TABLE 7. NET TRADE-OFFS OF FLOODS

Conditions	Situations, Choices, and Trade-Offs		
	I	II	III
Existing to $32 Budget	41 → 16 →	25 → 36 →	3
$32 Budget to $25 Budget	0	16 ← 32 ←	64
Existing to $25 Budget	41 → 12 →	29 → 36	3

There were significant differences in the purchase of flood situations between sample groups for the $32 budget but not for the $25 budget. No respondent bought situation I of floods with either budget. Although the $25 budget resulted in some trading off of floods from III to II, the choices overall were not dissimilar between groups. Ninety-three percent of the downstream

group, 66 percent of the adjacent respondents, and 80 percent of the reservoir respondents chose situation III with the $32 budget. The results could be indicative of the susceptibility of each sample group's area to flooding. The downstream residents are more apt to experience flooding, and more of that group chose situation III. The adjacent group was the least apt to experience flooding. Situation III was chosen by a smaller percentage of this group than by the other two groups.

Wildlife Habitat

Respondents believed the existing level of wildlife habitat in the reservoir area to be midway between situations II and III, with a mean value of 2.57 (Table 8). Chi-square tests revealed a significant difference in the way the three sample groups perceived the existing wildlife habitat. The downstream group was fairly evenly distributed, with the adjacent and reservoir groups more strongly choosing situation III.

Wildlife habitat at present was at an acceptable level to most respondents. Respondents chose a 2.6 level of wildlife habitat, for a SR of 1.01 with a $32 budget. They sacrificed only a small amount buying a 2.5 level, for a SR of 0.95, with a $25 budget. They gave up very little wildlife habitat from what they perceived existed.

TABLE 8. WILDLIFE HABITAT AVERAGE PET SCORE

Group	Wildlife Habitat Average "Score"				
	Existing Situation		$32 Budget		$25 Budget
Downstream	2.17		2.40		2.20
Adjacent	2.77		2.60		2.60
Reservoir	2.90	SR	2.90	SR	2.65
Mean	2.57	1.01	2.60	.95	2.46

Chi-square tests revealed a significant difference in the level of wildlife habitat bought by the three groups with both budgets. The reservoir respondents who chose the highest level of existing wildlife habitat were 90 percent for situation III with a $32 budget and 70 percent for situation III with a $25 budget (Table 9). The adjacent residents were 60 percent for situation III in both budget games. The downstream residents were 50 percent for

TABLE 9. WILDLIFE HABITAT PET CHOICES BY SAMPLE GROUP AND BUDGET LEVEL

	Reservoir		Adjacent		Downstream		Total	
	No.	%	No.	%	No.	%	No.	%
Existing Situation								
Sit. I - Wildlife Habitat	0	--	0	--	5	17	5	6
Sit. II - Wildlife Habitat	2	10	7	23	15	50	24	30
Sit. III - Wildlife Habitat	18	90	23	77	10	33	51	64
							80	100
$32 Budget								
Sit. I - Wildlife Habitat	0	--	0	--	3	10	3	4
Sit. II - Wildlife Habitat	2	10	12	40	12	40	26	32
Sit. III - Wildlife Habitat	18	90	18	60	15	50	51	64
							80	100
$25 Budget								
Sit. I - Wildlife Habitat	1	5	0	--	6	20	7	9
Sit. II - Wildlife Habitat	5	25	12	40	12	40	29	35
Sit. III - Wildlife Habitat	14	70	18	60	12	40	44	55
							80	100

situation III with $32, and 40 percent for III in the $25 game. The downstream respondents were more willing to trade-off wildlife habitat for other variables than were either the adjacent or reservoir residents. The downstream respondents also perceived the existing situation to be much lower than did either of the other two groups of respondents. Even with the $25 budget they chose an average level of 2.20, which is above what they believed existed, 2.17. They apparently believed that they were improving the habitat. The other two groups, adjacent and reservoir, each traded off a small amount of habitat from what they believed existed.

Very few trade-offs were made with the wildlife habitat variable (Table 10). There was a net move of two respondents from situation I to situation II between what respondents believed existed to what they bought with the $32 budget. This budget was large enough to permit their purchasing the desired levels of the other variables without sacrificing any wildlife habitat.

Net moves were made toward a lower level of wildlife habitat both between the $32 and $25 budgets and between the existing and $25 budgets. The net trade-offs for wildlife habitat were fewer than any of the other environmental variables as shown by wildlife habitat having SR's closest to one.

TABLE 10. NET TRADE-OFFS OF WILDLIFE HABITAT

Conditions	Situations, Choices, and Trade-Offs		
	I	II	III
Existing to $32 Budget	5 →→→ 2 →→→	24	51
$32 Budget to $25 Budget	3 ←←←←←←←←←←	26 ←←← 3 ←←←← 4 ←←←←←←←←←←	51
Existing to $25 Budget	5 ←←←←←←←←←←	24 ←←← 5 ←←←← 2 ←←←←←←←←←←	51

Land Recreation

The existing situation for land recreation had a mean value of 2.27. A significant difference was found between sample groups, with the downstream group distributed evenly among the choices, but weighted towards situation I. The adjacent and reservoir groups more often chose situation III as the existing situation for land recreation.

Respondents showed only slight dissatisfaction with the existing land recreation situation, with a SR of .92 for the $32 budget and .90 for the $25 budget (Table 11). The total utility of the respondents was maximized by purchasing a slightly different mix of environmental attributes than currently exists in the Valley.

TABLE 11. LAND RECREATION AVERAGE PET SCORE

Group	Land Recreation Average "Score"				
	Existing Situation		$32 Budget		$25 Budget
Downstream	1.80		2.13		1.97
Adjacent	2.40		2.17		2.10
Reservoir	2.80	SR	2.00	SR	2.15
Mean	2.27	.92	2.11	.90	2.06

Expenditures on the land recreation variable showed no significant difference among sample groups. All three groups tended to favor the land recreation depicted in situation II, trading off some of the land recreation potential for other environmental variables.

The land recreation average for reservoir residents increased from the $32 to the $25 budget. It went from 2.00 to 2.15. This was the only instance of the level of any variable increasing when the budget became restrictive. Respondents were willing to trade-off situation III of floods for situation II in the $25 game. The respondents gained $11 to spend on the remaining four variables by making this trade.

Net trade-offs resulting from budget changes show a willingness of respondents to give up some land recreation potential for a higher level of other variables. There was little net movement in any of the three situations (Table 12). Presented with a $32 budget, respondents moved away from situations I and III toward situation II, lowering the average level of land recreation potential desired only slightly. Respondents moved from the existing level to an overall lower level when presented with the more restrictive $25 budget.

TABLE 12. NET TRADE-OFFS OF LAND RECREATION

Conditions	Situations, Choices, and Trade-Offs		
	I	II	III
Existing to $32 Budget	17 →→ 3 →→	24 ←←← 16 ←←←	39
$32 Budget to $25 Budget	14 ← 10 ←←	43 →→→→ 6 →→→	23
Existing to $25 Budget	17 ↑←←←←←←←←	24 ←←←← 3 ←←← 7 ←←←←←←←←←←	39

Attitudes Toward the Proposed Dam

The priority evaluator technique was conducted to determine the relative value of wildlife in the Lower Sheyenne Valley, but a major concern of the respondents was the proposed dam. Due to recent flooding, the respondents were acutely aware of the flood situation and the consideration of a dam as a flood control measure. In general, downstream residents were in favor of a dam on the Lower Sheyenne River to help protect their property from flood damages. Adjacent and reservoir respondents were opposed to the dam, even though they expressed a dissatisfaction with the existing flood situation. The people living in the area of the dam and reservoir did not

want to have a dam because it would mean the loss of their homes and farmland. Downstream respondents would like to see a dam built and they represent a much larger population. The combined responses were 33 percent in favor and 61 percent opposed to a dam, with 6 percent not expressing an opinion (Table 13).

TABLE 13. RESPONDENTS' ATTITUDE TOWARD A DAM ON THE LOWER SHEYENNE RIVER OR A SIMILAR STREAM

Attitude	Sample Group			
	Downstream	Adjacent	Reservoir	Total
Strongly Favor	5	0	0	4 (5%)
Favor	18	3	1	22 (28%)
Do Not Know	2	3	0	5 (6%)
Oppose	6	17	3	26 (32%)
Strongly Oppose	0	7	16	23 (29%)
	30	30	20	80 (100%)

SOURCE: Survey done September-October, 1975.

Correlation coefficients showed that the sample group of the respondents was associated ($r = -0.52$) to their attitudes about the dam (Appendix C). Chi-square analysis of sample group and attitude about the dam resulted in a chi-square statistic of 0.0001, which shows a high degree of relationship between the two variables. A person's attitude about the dam could be predicted with confidence if his residence were known.

IV. SUMMARY AND CONCLUSIONS

Respondents were willing to give up, or trade off, some scenic view and some land recreation potential, with one exception,[1] in order to decrease the chances of flooding and increase water recreation activity. They preferred water recreation situation II and flood situation III. Although the level of wildlife habitat was high to begin with, there was no desire expressed to either increase it or to sacrifice it for higher levels of the other environmental variables. The variables, scenic view and land recreation, appeared to be valued less than wildlife habitat, since they were traded off more readily (Table 14).

[1]Reservoir respondents purchased a higher level of land recreation with the $25 budget than they had purchased with the $32 budget (Table 12).

TABLE 14. AVERAGE SCORES OF PET FOR EXISTING, $32, AND $25 CONDITIONS FOR SAMPLE GROUPS AND COMBINED RESPONSES

Variable	Group	Average Score		
		Existing Situation	$32 Budget	$25 Budget
Scenic View	Downstream	2.43	1.90	1.56
	Adjacent	2.46	2.30	2.06
	Reservoir	2.55	2.25	2.20
	mean	2.47	2.13	1.91
Water Recreation	Downstream	1.36	2.20	1.93
	Adjacent	1.33	2.13	1.73
	Reservoir	1.20	1.65	1.50
	mean	1.31	2.04	1.75
Floods	Downstream	1.36	2.93	2.53
	Adjacent	1.46	2.67	2.33
	Reservoir	1.85	2.80	2.30
	mean	1.52	2.80	2.40
Wildlife Habitat	Downstream	2.17	2.40	2.20
	Adjacent	2.77	2.60	2.60
	Reservoir	2.90	2.90	2.65
	mean	2.57	2.60	2.46
Land Recreation	Downstream	1.80	2.13	1.97
	Adjacent	2.40	2.17	2.10
	Reservoir	2.80	2.00	2.15
	mean	2.27	2.11	2.06

The graphs in Figure 4 summarize the responses for the priority evaluator technique. They show wildlife habitat to be the most stable of the five environmental variables, while floods were the most variable. Respondents wanted to see a considerable change made in the frequency of flooding. Water recreation choices indicated that situation II was most desirable.

The existing situation for scenic view and water recreation was perceived the same among groups but varied significantly for floods, wildlife habitat, and land recreation. The local residents, both adjacent and reservoir respondents, perhaps had a better knowledge of the wildlife habitat and potential land recreation that exists than did the downstream group. The difference in floods as seen by the sample groups could be due to the adjacent and reservoir respondents not experiencing the same threat of floods as the downstream residents. Even though the flood question was

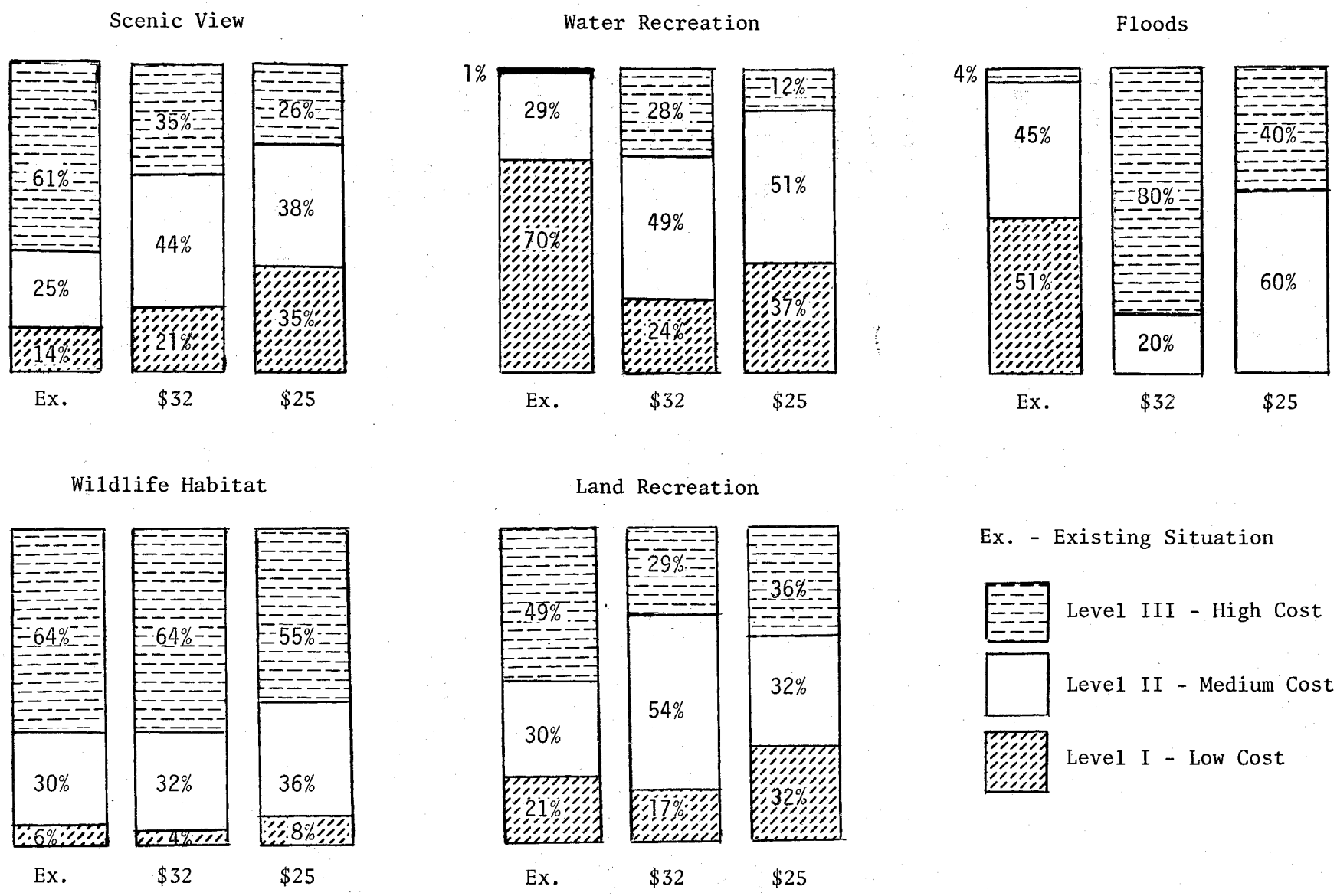


Figure 4. Existing situation and actual choices for different budgets.

asked of the Lower Sheyenne River in general, it was felt that the respondents reacted according to their specific area of residence.

The priority evaluator technique was used in this study because of its advantages over simply asking people what something is worth to them. PET simulates the marketplace and requires respondents to make decisions from among several choices which will affect their budget for the next choice. Wildlife habitat was more subtly presented with a group of other environmental variables.

Respondents thought they had a high-quality wildlife resource and desired to maintain that resource even if it meant giving up some other environmental amenities, such as scenic view or land recreation.

A majority of the respondents enjoyed working the model as they could relate to situations presented in the photographs. It was challenging and they seemed to enjoy trying to buy just the right package of environmental goods. A handful of respondents had difficulty understanding what they were asked to do, but usually understood the model before they had completed their tasks.

Use of the priority evaluator technique does have a major problem. First, the assumption of mutually exclusive and independent categories is extremely difficult to satisfy in the category selection and interviewing process. Separation of categories, such as water recreation and flood protection or land recreation and wildlife habitat, was nearly impossible when respondents were aware of a proposed dam and reservoir which would provide both flood protection and water recreation. One solution to this problem would be to combine categories into clearly mutually exclusive groups. This procedure, however, generates problems as it would be impossible to determine whether a respondent actually desired water recreation, flood protection, or both. Violation of the assumption of independence among categories also causes difficulty in pricing the different levels of each category.

The authors believe that PET is a valuable tool to gain insight into attitudes and to yield an estimate of trade-offs under alternative prices and budgets. The technique, however, requires additional research on the validity of results when one or more of its basic assumptions are violated.

APPENDIX A--DESCRIPTION OF SCENES

Scenic View

These three pictures highlight three types of natural land and riverscapes. The first picture shows substantial development along a reservoir, with the natural landscape a secondary factor of attraction. The second picture emphasizes gradual impact of man-made features on the natural vista. The third picture shows the river in its natural form, the river being the primary attraction of the total landscape.

Water Recreation

These three pictures highlight water recreational activities. The first shows the river flowing in a natural state. It offers little water-based recreation. The second picture depicts water recreation around a small impoundment. This situation offers some fishing, swimming, and boating. The third picture shows a large reservoir that offers good fishing swimming, boating, water skiing, and other water sports.

Flood Protection

These three pictures highlight flood dangers to farmland and property along the river. The first shows the recurring frequency of floods, with no protection provided. The second picture indicates a lesser frequency of flooding due to construction of some flood protection devices. The third picture emphasizes total protection from floods.

Wildlife Habitat

This column illustrates different qualities of wildlife-supporting habitat. The first picture illustrates poor wildlife habitat. The second picture highlights mediocre quality wildlife habitat. The third picture illustrates high-quality wildlife habitat.

Land Recreation

The potential for camping and other on-land recreation, differentiated from water-based recreation, is illustrated in these three pictures. The first picture highlights the lack of camping and on-land recreation. The second picture depicts the availability of some small parks and recreation facilities. The third picture illustrates the potential for several types of camping and on-land recreation, such as hiking, snow skiing, birding, or horseback riding.

APPENDIX B--SAMPLE CHARACTERISTICS

	Number	Percent
Total Respondents	80	100
Sex		
Male	36	45
Female	44	55
Age		
18-25	7	8.7
26-35	27	33.7
36-50	18	22.5
51-65	13	16.2
Over 65	15	18.7
Education		
8th Grade or Less	22	27.5
Some High School	5	6.2
High School	31	38.7
Technical School	4	5.0
Some College	7	8.7
College Graduate	9	11.2
Post Graduate	2	2.5
Income		
Below $3,000	6	7
$3,001 to $6,000	4	5
$6,001 to $9,000	12	15
$9,001 to $12,000	13	16
$12,001 to $15,000	21	26
$15,001 to $20,000	3	3
Over $20,000	9	11
Number of Children in Family		
0	7	8.7
1	14	17.5
2	14	17.5
3	21	26.25
4	12	15.0
5	8	10.0
6	2	2.5
7	2	2.5
Length of Time in Community		
Under 5 Years	13	16.2
5 to 10 Years	11	13.7
11 to 25 Years	13	16.2
More than 25 Years	43	53.7

APPENDIX C--CORRELATION ANALYSIS

Spearman correlation coefficients were calculated for the 15 PET choices and several socioeconomic characteristics (Table C1 and C2).

The values in Table C2 show that several of the variables are related to another. However, a relationship does not mean that a change in one variable causes or is caused by a change in another variable. They could both be associated with a third variable responsible for their change.

Some examples of high correlation or relationship between two variables are: 1) wildlife habitat purchased with the $25 budget and floods with that same budget (r = -0.83), 2) land recreation purchased with the $25 budget and floods with that same budget (r = -0.73), and 3) wildlife habitat purchased with the $25 budget and land recreation with that same budget (r = -0.66) (Table C2).

APPENDIX TABLE C1. DESCRIPTION AND RANGE OF VARIABLES USED IN STATISTICAL ANALYSIS

Description	Symbol	Range
Dependent Variables		
Existing Scenic View Choice	SVE	1, 2, 3
Existing Water Recreation Choice	WRE	1, 2, 3
Existing Floods Choice	FLE	1, 2, 3
Existing Wildlife Habitat Choice	WHE	1, 2, 3
Existing Land Recreation Choice	LRE	1, 2, 3
$32 Budget Scenic View Choice	SVTT	1, 2, 3
$32 Budget Water Recreation Choice	WRTT	1, 2, 3
$32 Budget Floods Choice	FLTT	1, 2, 3
$32 Budget Wildlife Habitat Choice	WHTT	1, 2, 3
$32 Budget Land Recreation Choice	LRTT	1, 2, 3
$25 Budget Scenic View Choice	SVTF	1, 2, 3
$25 Budget Water Recreation Choice	WRTF	1, 2, 3
$25 Budget Floods Choice	FLTF	1, 2, 3
$25 Budget Wildlife Habitat Choice	WHTF	1, 2, 3
$25 Budget Land Recreation Choice	LRTF	1, 2, 3
Attitude About Proposed Dam	DAM	2 (Strongly Approve) 1 (Approve) 0 (Do Not Know) -1 (Oppose) -2 (Strongly Oppose)
Independent Variables		
Education of Respondent	EDUCATE	1 8th Grade or Less 2 Some High School 3 High School Grad 4 Tech School 5 Some College 6 College Grad 7 Graduate Work
Employment of Head of Household	JOB	0 Nonfarmer 1 Farmer
Length of Residence in Community	TENURE	1 Under 5 Years 2 5 to 10 Years 3 11 to 25 Years 4 More Than 25 Years

- continued -

APPENDIX TABLE C1. DESCRIPTION AND RANGE OF VARIABLES USED IN STATISTICAL ANALYSIS (CONTINUED)

Description	Symbol	Range
Age of Respondent	AGE	1 18-25 Years 2 26-35 Years 3 36-50 Years 4 51-65 Years 5 Over 65 Years
Sex of Respondent	MALE	0 Female 1 Male
Number of Children in Family	KIDS	0 through 7
Total Family Income	INCOME	1 Below $3,000 2 $3,001-$6,000 3 $6,001-$9,000 4 $9,001-$12,000 5 $12,001-$15,000 6 $15,001-$20,000 7 Over $20,000
Outdoor Recreation Acitivities (Average participation in outdoor recreation activities determined by averaging 13 activities)	AVEREC	0 through 2
Sample Group	SAMPGRU	1 Downstream 2 Adjacent 3 Reservoir

APPENDIX TABLE C2. SPEARMAN CORRELATION COEFFICIENTS OF SOCIOECONOMIC VARIABLES AND DEPENDENT VARIABLES, PET

	SVE	WRE	FLE	WHE	LRE	SVTT	WRTT	FLTT	WHTT	LRTT	SVTF	WRTF	FLTF	WHTF	LRTF	SAMPGRU	EDUCATE	TENURE	AGE
SVE	1.00																		
WRE	-0.15	1.00																	
FLE	0.27	-0.03	1.00																
WHE	0.19	-0.29*	0.12	1.00															
LRE	0.06	-0.11	0.21	0.37*	1.00														
SVTT	0.38*	-0.10	0.13	0.19	0.24	1.00													
WRTT	-0.22	0.05	-0.07	-0.31*	-0.16	-0.36*	1.00												
FLTT	-0.16	0.19	-0.05	-0.06	-0.23	-0.56*	-0.04	1.00											
WHTT	-0.11	-0.21	0.11	0.17	0.27	0.12	-0.29*	-0.19	1.00										
LRTT	-0.26	-0.09	-0.11	0.06	0.30*	-0.06	0.13	-0.49*	0.29*	1.00									
SVTF	0.29*	-0.11	-0.06	0.27	0.24	0.78*	-0.46	-0.47*	0.15	-0.02	1.00								
WRTF	-0.23	0.24	-0.13	-0.20	-0.18	-0.44*	0.62*	0.15	-0.13	0.04	-0.49*	1.00							
FLTF	-0.04	0.04	0.21	-0.35*	-0.27	-0.38*	0.17	0.43*	-0.24	-0.23	-0.64*	-0.06	1.00						
WHTF	0.03	0.01	-0.17	0.18	0.18	0.29*	-0.09	-0.19	0.35*	0.15	0.46*	0.16	-0.83*	1.00					
LRTF	-0.07	0.03	-0.10	0.26	0.45*	0.30*	-0.11	-0.33*	0.37*	0.52*	0.45	-0.07	-0.73*	0.66	1.00				
SAMPGRU	0.07	-0.14	0.32*	0.17	0.36*	-0.01	-0.32*	0.14	0.33*	-0.11	0.09	-0.19	-0.03	0.08	0.02	1.00			
EDUCATE	-0.06	0.18	0.00	-0.37*	-0.16	0.02	0.21	0.01	-0.11	-0.07	-0.02	0.03	0.19	-0.18	-0.04	-0.07	1.00		
TENURE	0.42*	-0.42*	0.06	0.45*	0.26	0.09	-0.29*	-0.11	0.37*	0.21	0.11	-0.15	-0.22	0.23	0.15	0.20	-0.45*	1.00	
AGE	0.31*	-0.31*	-0.06	0.29*	0.10	0.13	-0.21	-0.09	0.16*	0.25	-0.08	-0.10	-0.09	0.08	-0.04	0.15	-0.55*	0.67*	1.00
KIDS	0.30*	-0.44	-0.20	0.38*	0.00	0.12	-0.21	0.05	-0.10	-0.12	0.13	-0.06	-0.08	0.00	-0.07	-0.01	-0.34*	0.42*	0.31*
INCOME	0.24	0.03	0.21	0.40*	0.07	0.01	0.05	0.07	-0.07	0.02	-0.14	0.00	0.13	-0.31*	-0.08	0.01	-0.07	0.24	0.01
DAM	-0.07	0.16	-0.19	-0.36*	-0.35*	-0.17	0.23	0.07	-0.48*	-0.06	-0.22	0.19	0.16	0.23	-0.29*	-0.52*	-0.03	-0.34*	0.00
AVEREC	0.02	0.16	0.23	-0.22	0.10	0.42*	-0.06	-0.29*	0.09	-0.04	0.31*	-0.15	-0.03	-0.01	-0.15	0.22	0.42*	-0.30*	-0.53*

*P<0.05

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