Chapter 5
EXPERIMENTAL BENEFITS ESTIMATES: OVERALL, USE AND, INTRINSIC

In this chapter we examine the WTP amounts given by our respondents. The analysis begins with an examination of the level of benefits for national water quality revealed by our respondents. We then test the predictive power of a theoretically-based estimation of the amounts; an important test of our instrument's hypothetical bias. The next section presents our technique for separating intrinsic from recreational benefits and illustrates it with our data. In the final section we consider the regional variation in water benefits and discuss procedures by which the data from a national water benefits survey may be helpful to those who wish to estimate water benefits for sub-national areas.

Before proceeding further it is important to emphasize that the benefit estimates we discuss below come from experimental data and should not be used for making definitive national estimates. Our study was designed to develop a new methodology and to test it to see if it shows sufficient promise for a full scale application (after appropriate revision). As noted in the last chapter, our macro WTP instrument was very successful with the exception of the item non-response rate. The nonresponse rate problem is correctable (see the Conclusion for our proposals), but it means the present set of WTP amounts represents a selective rather than a random sample of the U.S. population. Although our data are not sufficiently representative for national estimates, they are sufficiently free from bias to warrant the analysis we undertake in this chapter. In this sense the estimates discussed in the next section may be taken as illustrative, in a rough way, of the benefit estimates which a revised national survey might produce.

ILLUSTRATIVE ESTIMATES

Taking into account the above caveat, we discuss here the WTP amounts given by our respondents. This sample consists of all those[1] who were exposed to Versions A, B, or C of the questionnaire and who gave us usable amounts (including zero bids). The number of cases on which the analyses in this chapter are based vary from 771 to 695 according to whether or not we had to drop cases because of missing data on individual items.

Amounts by Version

As described in Chapter 2, the respondents valued three levels of water quality which were described in words and depicted on the water quality ladder. They were first asking how much they were willing to pay to maintain national water quality at the boatable level. Subsequent questions asked them their willingness to pay for overall water quality to fishable quality and swimmable quality. The mean WTP amounts given by the respondent for the two higher levels consists of the amounts they offered for the lower levels plus any additional amount they offered for the higher level. Table 5.1 gives the mean WTP amounts for each of the three versions.

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[1] With the exception of a handful of respondents whose answers to the questionnaire were so contradictory that they were judged to be meaningless. The removal of these 22 cases presents no bias to the WTP amounts as their mean WTP amount is the same as the entire sample's. Appendix VI describes our rationale for dropping these respondents and gives information about each case.

Table 5.1 MEAN AMOUNTS WILLING TO PAY ANNUALLY PER HOUSEHOLD FOR BOATABLE, FISHABLE AND SWIMMABLE WATER QUALITY IN THE UNITED STATES BY VERSION AND INCOME LEVELS[1]

Level D Boatable[2]

Income Levels	Version A	Version B	Version C
1	$ 61 (62)	$ 47 (61)	$ 71 (64)
2	114 (38)	124 (48)	87 (38)
3	183 (78)	135 (79)	174 (82)
4	289 (73)	262 (48)	308 (50)
Total	$168 (274)[3]	$133 (255)[3]	$161 (242)[3]

Level C Fishable

Income Levels	Version A	Version B	Version C
1	$77	$60	$91
2	161	149	111
3	229	201	223
4	363	347	362
Total	$214	$180	$198

Level B Swimmable

Income Levels	Version A	Version B	Version C
1	995	$76	$103
2	195	163	128
3	268	244	267
4	404	394	375
Total	$247	$212	$222

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[1] *The amounts shown here derive from experimental research and should not be used for national estimates.* In this version of the research instrument those who did not give an amount in answer to the willingness-to-pay questions received no further encouragement to do so by the interviewers. As a consequence, 32 percent of the respondents (for fishable water it was 32% for version A; 30% for version B; and 34% for version C) did not give amounts. The 32 percent who did not give an amount is comprised of 24 percent who said they ''don't know," 6 percent "it depends" and 2 percent who refused to answer.

[2] The percent who said $0 were 18%, 22% and 24% in version A to C respectively.

[3] The total N's are larger than the sum of the N's for the four income levels because they also include those who answered the willingness-to-pay questions but were not willing to give their income. Since these people could not be assigned to their correct income group the interviewers were told to treat them as if they were in income level 4. If we include those who did not give an amount, the total N's for the three versions are: A-431; B-380; and C-410.

It shows the following:

1. The pattern of amounts is quite consistent across the three versions of the instrument. As noted in Chapter 4 only two of the 36 between-version comparisons show differences that are statistically significant at the .05 level.
2. The effect of respondent's income is uniformly strong as shown by the column amounts. This is an expected effect, of course, since people with higher incomes a) have more disposable income, and b) were shown payment cards whose benchmark amounts for non-environmental public goods were higher.
3. The WTP amounts are substantial. This is in contrast with the earlier macro WTP studies described in Chapter 2 which did not describe the hypothetical market for their goods in detail.

<u>Combined Amounts</u>

The WTP amounts for the combined sample are shown in Figure 5.1. The most substantial benefit is for boatable water with a range of $136-168 per annum per household. The respondents were willing to pay $175-213 for fishable water, an amount 27 percent higher than the boatable estimate.[2] According to these data, national water of swimmable quality yields a diminishing return as the swimmable WTP amount is only 16 percent greater than the fishable amount.

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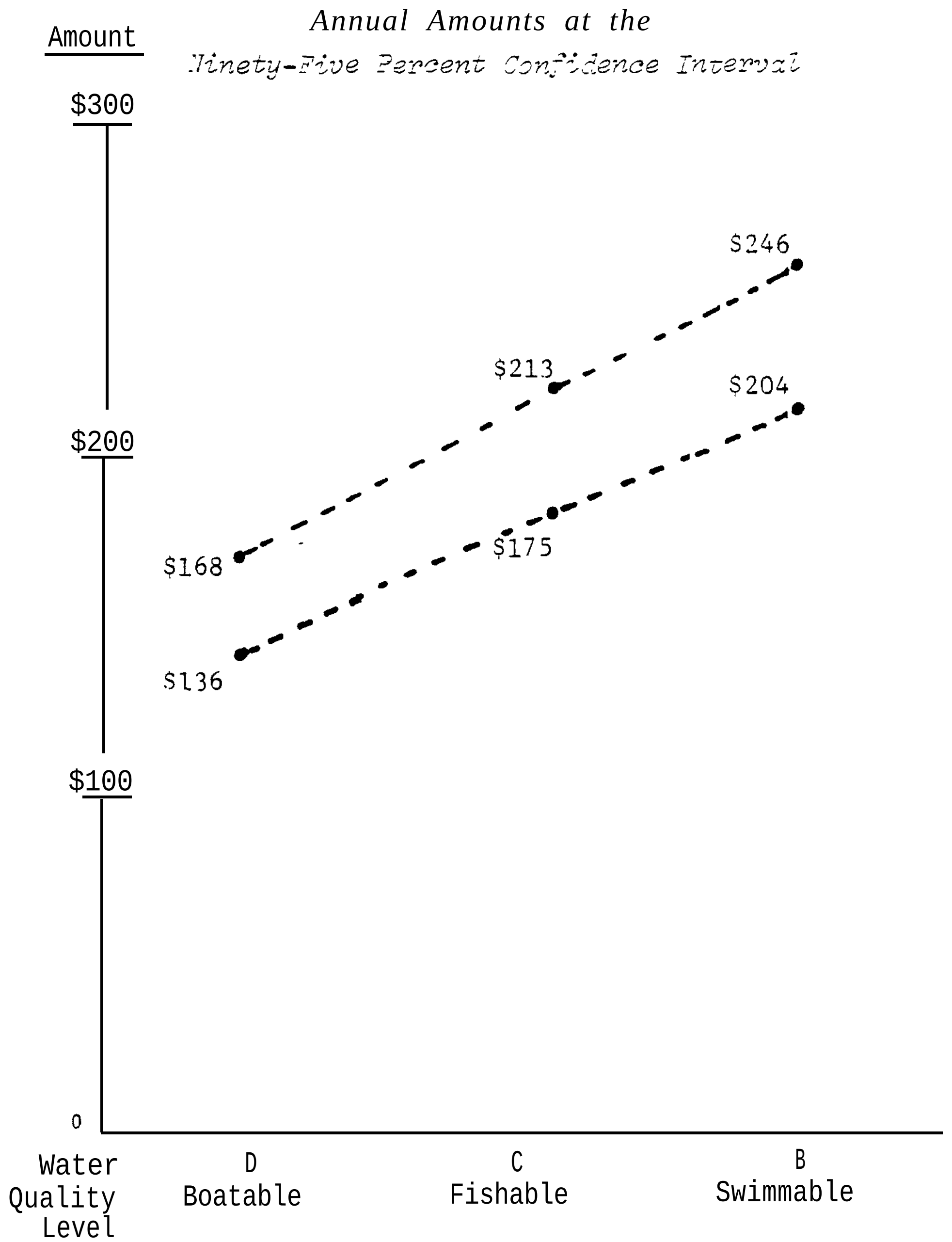
[2]The mean amount which <u>this sample</u> of people is willing to pay for swimmable water quality is approximately the amount paid in taxes and higher prices in 1979 for water pollution control by U.S. households according to the estimates of the President's Council on Environmental Quality. The CEQ estimate for 1979 amounts to $159 per household for control instituted as a result of federal pollution control programs and $255 for all water quality expenditures ,including those which industry would have undertaken irrespective of the federal pollution control laws (Council on Environmental Quality, 1980:394, 397).

For these experimental data the total annual benefits for swimmable water nationwide lie somewhere between 9 and 22 billion dollars. No point estimate should be inferred from this range for the reasons explained in detail in the report.

Figure 5.1 WHAT PEOPLE ARE WILLING TO PAY EACH YEAR PER HOUSEHOLD FOR DIFFERENT LEVELS OF NATIONAL WATER QUALITY



	D Boatable	C Fishable	B Swimmable
Mean =	$152	$194	$225
SE of mean =	$8.03	$9.55	$10.57
N =	748	748	748

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[1] *For Versions A, B & C combined. These estimates are based on experimental data and should not be used for true national estimates.*

Effect of Knowing Amount Being Paid

Some of the earlier macro WTP studies (Viladus, 1973) show that people are more willing to pay higher amounts for public goods when they are told the amount it will cost (or is costing) than when they do not have this information. In order to see if this is the case in our study, we departed from our previous format in Version D of our research instrument and told the respondents what they are paying for water pollution control.[3] In our case the revealed value for water quality in Version D is quite similar to that for the combined A, B, C versions where the respondents were not told how much they are paying.

Forty-seven percent of the 354 respondents to Version D said they were willing to pay the amount shown on their card for water pollution control (which they were told would raise the overall level of national water quality to fishable in the next few years) and 12 percent volunteered that "it depends." Thirty percent were not willing, 11 percent were not sure or didn't know, and less than one percent did not answer the question. Those who were not willing to pay the amount were asked how much they were willing to pay to keep the quality of water at boatable quality whereas those who were willing to pay the amount were asked to value an increase in quality from fishable to swimmable (level B). It is possible to calculate values for fishable and swimmable water from these data.[4] The Version D range for fishable water

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[3] They were shown on the payment card an estimate of what households in the respondents' income range were actually paying for water pollution control.

[4] In making this calculation we assign each person who is willing to pay the amount shown on the payment card for water pollution control that value as their WTP value for fishable water. Under the assumption that those who said "it depends" would be willing to pay that amount too if they could be assured that it would achieve the fishable water quality goal, we also counted them as willing to pay the amount shown. Those who gave amounts for boatable water but not for fishable, were counted as also willing to pay the boatable amounts for fishable water quality.

quality is $185-233 compared to the A, B, C combined range of $175-213. The WTP amounts for swimmable water given by the Version D respondents are somewhat higher than those given by the respondents to the other version.

EXPLANATION OF WILLINGNESS TO PAY FOR WATER QUALITY

Model Specification

A test of the hypotheticality of WTP studies is whether or not the respondent's values can be explained by a set of theoretically relevant factors. If the WTP questions are sufficiently meaningful to the respondent, his or her answers should be constrained by those factors which affect such matters in everyday circumstances. Surprisingly few WTP studies have reported regression estimations and of these only one or two include the range of factors which theory and empirical research suggest as possible explanatory factors.[5]

We propose the following as the appropriate determinants of willingness to pay:

WTP = f(Respondents' Income, Education, Age, Environmental Attitudes, Availability of Freshwater, Attitudes Towards Water Quality)

In our original estimation several of these factors did not enter into the equation significantly.[6] Hence we removed these variables and re-estimated

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[5]For WTP studies which report lack of success in explaining the bids by regression equations see Eastman, et al. (1978) and Thayer(forthcoming). The only studies which use a range of variables comparable to ours include, interestingly, the two previous WTP studies of water quality (Gramlich, 1977; Walsh, et al. 1978) in the published literature.

[6]These include several dimensions of the respondents' attitudes toward water quality (e.g. desired quality levels of national freshwater, perceived changes in local water quality) and the availability of freshwater for recreational use.

the equations. The coefficients and the significance levels of the remaining variables were not appreciably different from the larger equations. Because we believe that major conceptual and definitional problems exist with some of the nonsignificant variables we will not report the results of these larger equations here. The variables which remain and our measures of them are as follows:

Income -- The higher the respondents' family income, the larger the amount of disposable income the respondent has available for water quality. We measured income by the standard survey research procedure of presenting the respondent with a card which contains a list of income categories. The respondent was asked: "Would you call off the letter of the category that best describes the combined (emphasis in the original) annual income of all members of this household, including wages or salary, pensions, benefits, interest or dividends, and all other sources?" Thus we asked for household not personal income. Table 5.2 presents the list of income categories and the percent of respondents in each category. Note that 10 Percent of the respondents refused to reveal their household income. This level of item nonresponse is within the range found by the major survey research organizations in national samples of our type. We decided not to substitute mean values for these cases but simply to drop them from the regression part of our analysis.

Table 5.2 INCOME RANGES FOR THE RFF SURVEY

Income Range	Percent of Sample[1]	Levels used for Payment Cards
Under $4,000	7%	I
$4,000 to $5,999	7	I
$6,000 to $7,999	5	I
$8,000 to $9,999	7	I
$10,000 to $11,999	7	II
$12,000 to $14,999	9	II
$15,000 to $19,999	13	III
$20,000 to $24,999	15	III
$25,000 to $49,999	19	IV
$50,000 and over	3	IV
Not sure/refused	10	

[1] These data are for the entire sample, all versions.

Following the standard procedure (Kemnta, 1971) for incorporating grouped income data in regression equations where the actual income is unobtainable, we assigned each respondent the mid point for his or her income category. A value of $60,000 was used for the $50,000 and over category.

Age -- Studies of the determinants of environmental attitudes identify age as an important predictor (Dunlap and Van Liere, 1978; Mitchell, 1980:44). Younger respondents are somewhat more supportive of environmental protection than older respondents. The WTP studies which report regression estimations show mixed findings on the relationship between age and willingness to pay for environmental public goods. Walsh, et al. (1978:66) found a significant negative relationship between age and willingness to pay for water quality in the South Platte River Basin. Age did not enter significantly into the regressions estimated by Gramlich in his study of the Charles River Basin (1977:187) and in Eastman, et al.'s (1978:22) study of air visibility in the Four Corners area it showed no consistent pattern.

Our age measure consists of a card listing eleven age categories from which the respondent chose the correct age group for him or herself. The first two age categories are 18-21 and 22-24. Beginning with age 25-29, the categories proceed by five year intervals until the last group which was defined as 65 or older. If the respondent refused to provide the age information, the interviewer was instructed to make an estimate. We coded the age variable at the mid points for each age category. For the 65 and over category we used 70 which is the approximate mid point of this age category according to census data.

Education -- Education is also correlated with support for environmental protection; the higher the educational level, the greater the level of environmental concern (Dunlap and Van Liere, 1978:9; Mitchell, 1980:44). Two WTP studies also report a similar relationship with willingness to pay for environmental public goods (Walsh, et al., 1978:60; Gramlich, 1977:187).

Our measure of education consists of six categories, ranging from no-school-to-grade 8 to post graduate education (17 years of formal education or more). Each category was designed to be a qualitatively equivalent increase in educational attainment from the next lower category with special weight given to the completion of high school and college.[7] For this reason our variable consists of the categories instead of the mid point of the years of education represented by each category.

Environmental Attitudes -- Numerous social surveys have measured people's attitudes towards environmental issues (for a review see Dunlap and Van Liere, 1978). The questions used for this purpose measure a wide variety of dimensions such as concern, perceived seriousness, tradeoffs, and relative importance. On each of these dimensions

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[7] These levels are as follows:

Code	Education Category (no.of yrs)	Percent in Total Sample
2	No school, grade school (l-8)	9%
3	Some high school (9-11)	16
4	High school graduate (12)	38
5	Some college (13-15)	20
6	College graduate (16)	11
7	Post graduate (17+)	6
	No response	1

people can be arrayed along a continuum from those who describe themselves as valuing environmental amenities a great deal to those for whom environmental amenities have lesser value. It is to be expected that people's WTP for environmental amenities should be related to their "environmentalism" as revealed by these kinds of attitude questions. The only previous attempt to our knowledge to demonstrate this in WTP studies failed to find a relationship, however, The Colorado State study included a question about the respondents' general awareness of environmental problems in the study area which did not enter into any of their regression estimations (Walsh, 1978: 83-4. 88-9).

The portion of our research instrument preceeding the WTP instrument contained a large number of environmental attitude measures. From these we constructed 7 item environmental index (ENVINDEX). The items for this index were chosen subjectively. We included items which our previous analysis of these data had shown to be measures of the degree to which the respondent valued environmental goods. In addition to an item which posed tradeoffs between environmental protection and cost, the index includes items which measure the respondents' attitude toward the environmental movement, the degree to which they rank environmental concerns high or low compared to other national priorities, and whether they have lobbied public officials by letter or personal contact on an environmental issue. The items contained in the index, its manner of construction and its distribution are described in Appendix VIII. To test its metric qualities we re-estimated our regression equations using several different forms of the index to see if the parameters of the other variables or the R^2 of the equations were affected. The results of these tests suggest the use of the linear form.[8]

<u>Concern About Water Pollution</u> -- None of the items in the environmental index treat water pollution because we wanted to see if concern about water pollution had the separate effect on willingness to pay we thought it should. The item in our questionnaire which measured water pollution concern was one of a series of items about which the respondent was asked:

> (Q.11) Now I'd like to find out how worried or concerned you are about a number of problems I am going to mention: a great deal, a fair amount, not very much, or not at all. If you aren't really concerned about some of these matters, don't hesitate to say so.
>
> C. Cleaning up our waterways and reducing water pollution.

In answer to thise question, thirty-nine percent said they were concerned a great deal, 44 percent a fair amount, 13 percent not very much and 3 percent not at all. We constructed a dummy variable CWPOLD) where 1 - those who say they are concerned a great deal and 0 = the remainder.

<u>Recreational Use of Water</u> -- We reasoned that the greater the respondent's recreational use of freshwater, the greater value water pollution control

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[8] We estimated equation 2 (Table 5.4) using squared and cubed forms of ENVINDEX in addition to ENVINDEX. The squared and cubed forms were insignificant. Equation 2 was also estimated substituting the log ENVINDEX for ENVINDEX. The R^2 of this equation was lower. In both of these cases we used F tests to test whether any of these alternative equations had significantly different coefficients for the other parameters in the equation 2. Each F test of the paired coefficients was insignificant. As a result of these tests we decided to use the linear form of the index.

would have for him or her. Previous WTP studies examined the relationship between recreational use and willingness to pay without finding any correlation. The Colorado State study regressed the reported number of water-based recreation activity days experienced annually in the South Platte River Basin and the degree to which respondents liked outdoor water-based recreation on their WTP measures and found no effect (Walsh, et al., 1978:52, 69-72). Similar findings of no or marginal significance for recreational use are also reported for air quality (Eastman, et al., 1978:16-17) and water quality (Gramlich, 1977:187).

We measured recreational freshwater use by a series of questions (Qs. 58-66 in Appendix IV) which asked the respondent whether in the past two years he or she had gone:

- "sailing, canoeing, power boating, water skiing and the like"
- "swimming in a freshwater lake or stream as opposed to a swimming pool or the ocean"
- "fishing in a freshwater lake or stream"

Each person who said yes to an item was asked further whether he or she did this "within fifty miles of your home, or farther away, or both?" and "roughly how many times would you say you (did the activity) over the past two years?" Personal use of freshwater for these purposes varied from 34 percent who went fishing to 39 percent who went boating, We tested various forms of a recreational measure and our tests showed that neither the location of use nor the amount of use contributed to the estimation, a finding similar to the Colorado State study. We therefore created a simple dummy variable, USERD, which was set at 1 for those who reported freshwater use of any kind over the past two years (60 percent of the sample) and 0 for those who reported no personal use during this time period.

Estimation

Our final explanatory model for national water quality values consists of six variables: three are socioeconomic characteristics, two are attitudinal measures and one is a self-reported behavioral measure. Table 5.3 gives the Pearson(r) correlation matrix for these variables. Although no correlation is .40 or above, three of the fifteen are above .30. Multicollinearity cannot be ruled out, but the symptom of insignificant coefficient estimators in conjunction with large R^2 values was not observed.

(continue)

Table 5.3 CORRELATION MATRIX FOR VARIABLES USED IN THE REGRESSION EQUATIONS

	INCOME	AGE	EDUC	ENVINDENX	CWPOLD	USERD
INCOME	1.00000 0.0000	-0.07698 0.0425	0.37733 0.0001	0.05241 0.1675	-0.05756 0.1295	0.16160 0.0001
AGE	-0.07698 0.0425	1.00000 0.0000	-0.27897 0.0001	-0.25041 0.0001	-0.05206 0.1704	-0.32212 0.0001
EDUC	0.37733 0.0001	-0.27897 0.0001	1.00000 0.0000	0. 20955 0.0001	0.02733 0.4719	0.19735 0.0001
ENVINDEX	0.05241 0.1675	-0.25041 0.0001	0.20955 0.0001	1.00000 0.0000	0.34516 0.0001	0.23361 0.0001
CWPOLD	-0.05756 0.1295	-0.05206 0.1704	0.02733 0.4719	0.34516 0.0001	1.00000 0.0000	-0.00231 0.9516
USERD	0.16160 0.0001	-0.32212 0.0001	0.19785 0.0001	0.23361 0.0001	-0.00231 0.9516	1.00000 0.0000

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
INCOME	695	19946.8	13647.8	13863000	2000	60000
AGE	695	42.3	16.0	29418	20	70
EDUC	695	4.3	1.3	2978	2	7
ENVINDEX	695	6.4	1.8	4439	1	11
CWPOLD	695	0.4	0.5	285	0	1
USERD	695	0.6	0.5	435	0	1

Equations were estimated using ordinary least squares regression for the three levels of water quality as shown in Table 5.4. The patterns for the three levels are very similar with the fit, as measured by R^2, increasing slightly from .28 for the boatable equation to .31 for the swimmable one. Using the swimmable equation as our example, each of the independent variables is statistically significant at the .05 level or better. Income is the major factor in the equation followed by the environmental index. Despite its affinity with the index, concern about water pollution enters separately at a highly significant level. The recreation use variable also enters, although in the boatable equation its t value is slightly below the .05 level.

Alternative functional forms for these equations were tested. The most obvious candidate for an alternative form, considering our strong income effect, is a log-log estimation (Gramlich, 1977). The results for this type of estimation were not appreciably different or better than the OLS estimation except that the significance of the recreational use variable was increased.[6]

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[6] The results of the log-log estimation for fishable waters are as follows:

Dependent Variable = Log of Level C

	Coefficient	t
Intercept	-4.24	-4.89
LOG INCOMER	0.70	7.50
EDUC	.29	4.73
AGECAT	-.13	-5.53
ENVINDEX	.32	7.06
USERD	.85	5.39
CWPOLD	.27	1.81
N = 645	R^2 = .39	F = 74.33

Table 5.4 OLS REGRESSION OF DEMOGRAPHIC AND ATTITUDINAL VARIABLES ON WILLINGNESS TO PAY AMOUNTS FOR THREE LEVELS OF NATIONAL WATER QUALITY[1]

	Levels of Water Quality					
	eq. 1 Boatable (D)		eq. 2 Fishable (C)		eq. 3 Swimmable (B)	
	Coefficient	(t)				
INTERCEPT	-141.91	(-3.07)	-163.83	(-3.03)	-143.47	(-2.41)
INCOME	.0058	(10.36)	.0072	(10.95)	.0075	(10.43)
AGE	-1.34	.-2.85)	-1.84	(-3.25)	-2.60	(-4.16)
EDUC	14.39	(2.27)	15.15	(2.04)	17.35	(2.12)
ENVINDEX	21.81	(4.79)	28.74	(5.40)	31.77	(5.46)
CWPOLD	47.90	(3.11)	51.18	(2.84)	56.68	(2.86)
USERD	27.25	(1.71)	40.88	(2.20)	45.52	(2.23)
N	695		695		695	
R^2	.28		.31		.31	
F	44.54		50.61		51.39	

[1] For Versions A, B, C combined less a few cases which were dropped for reasons described in Appendix VI.

Heteroskedasticity is to be expected in regression equations which use any kind of consumer expenditure data (Prais and Houthacker, 1955) and our estimations are no exception. Initial tests of heteroskedasticity showed we had heteroskedasticity with respect to almost very variable. Since the presence of heteroskedasticity indicates that the OLS assumption of a covariance matrix of the form $\sigma^2 I$ has been violated, a generalized least squares (GLS) procedure must be used to obtain correct parameter estimates. (Johnson, 1932; Rao, 1965). The GLS procedure uses the covariance matrix Ω instead of $\sigma^2 I$. The GLS estimator of $\hat{\beta}$ is

(1) $\hat{\beta} = (X'\Omega^{-1}X)^{-1}X'\Omega^{-1}y$

and the variance of the GLS estimator is

(2) $\operatorname{var} \hat{\beta} = \sigma^2(X'\Omega^{-1}X)^{-1}$

When Ω^{-1} is known, estimation of the GLS estimator is straightfoward. When Ω^{-1} is not known, special techniques must be used to estimate it.

Standard adjustments such as weighting by $1/\text{income}^2$ (Johnson, 1972) or $1/\hat{Y}^2$ (Goldberger, 1964) did not correct the problem. Since the standard constructive tests for heteroskedasticicy are not appropriate for a combination of dummy and continuous variables such as ours (except for some maximum likelihood estimators and some sophisticated grouping techniques which are almost impossible to implement) we devised our own test. Inspired by the Park test, the Carson-Vaughan constructive test uses a semilog weight transformation.[7]

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[7] See Appendix VIII for an extended discussion.

Table 5.5 presents the estimations corrected for heteroskedasticity. The income coefficients and significance levels are now 20 percent lower than in the OLS equations. Significance levels for education and the two environmental attitude variables are also reduced while those for age and recreational use are increased somewhat.

To give an indication of price flexibility we calculated the ranges shown in Table 5.6. The range is from moderate inelastic to unitary elasticity. They are slightly higher but in the same general range as those found by Brookshire, et al. (1980:485) for elk hunting (.306) and Randall, et al. (1974:147) for air pollution (.39 - .65).

Given the size of our sample, the fact that our explanatory variables are chosen for their theoretical relevance, and the cross-sectional character of data; the variance explained by our model is reasonably high. We regard this as important evidence that the contingent market described in our research instrument is sufficiently realistic to minimize hypothetic bias.

Table 5.5 ADJUSTED[1] REGRESSION OF DEMOGRAPHIC AND ATTITUDINAL VARIABLES ON WILLINGNESS TO PAY AMOUNTS FOR THREE LEVELS OF NATIONAL WATER QUALITY

	Levels of Water Quality					
	eq. 4 Boatable (D)		eq.5 Fishable (C)		eq. 6 Swimmable (B)	
INTERCEPT	-30.61	(-1.14)	-25.63	(.80)	5.97	(.17)
INCOMER	.0047	(8.71)	.0058	(9.06)	.0062	(8.75)
AGE	-1.01	(-3.71)	-1.48	(-4.56)	-2.15	(-5.77)
EDUC	8.70	(2.24)	10.37	(2.25)	12.52	(2.47)
ENVINDEX	8.42	(3.28)	11.04	(3.63)	12.14	(3.56)
CWPOLD	30.34	(3.09)	34.30	(2.97)	38.62	(2.91)
USERD	24.06	(2.69)	32.92	(3.07)	30.73	(2.58)
N	695		695		695	
R^2	.28		.32		.33	
F	45.02		52.82		55.79	

[1] Data are adjusted for heteroskedasticity by the Carson-Vaughan Constructive Test (see Appendix VIII for description).

Table 5.6 PRICE FLEXIBILITY OF INCOME

Level D	.68 - 1.06
Level C	.70 - 1.12
Level B	.69 - 1.12

The high end of the range for the price flexibility of income for the different levels of water quality was estimated from the equation:

(1) $$\text{Log(Level X)} = \text{Intercept} + \beta_1 \text{Log(Income)}$$

The low end of the range was estimated from the equation:

(2) $$\text{Log(Level X)} = \text{Intercept} + \beta_1 \text{Log(Income)} + \beta_2 \text{Educ} + \beta_3 \text{Age} + \beta_4 \text{ENVINDEX} + \beta_5 \text{USERD} + \beta_6 \text{CNPOLD}$$

Because income is moderately correlated with some of the variables in (2) only a range rather than a point estimate can be given.

INTRINSIC AND RECREATION BENEFITS

In Chapter 1 we identified direct use recreation benefits and intrinsic benefits (which include indirect, option and existence benefits) as the subject matter of our research. Unlike the Colorado State researchers, we did not ask our respondents separate WTP questions for each type of benefit we sought to measure. We believe it is beyond the capability of many respondents to reliably determine the separate value they have for sub-categories of water benefits and the results of the Colorado State study confirm us in this belief. Our approach adopts a different technique which we will describe and illustrate with our data.

At the heart of the distinction between recreational and intrinsic benefits is the direct use vs. other-than-direct-use distinction. The latter, our intrinsic category, includes a wide array of benefits ranging from indirect benefits to duck hunters of "clean" water to the pleasure gained from knowing that the nation's freshwater bodies have attained a certain quality level. Since our WTP questions measure the overall value respondents have for water quality, the amount given by each respondent represents the combination of recreational and intrinsic values held by that person. We reason the values expressed by the respondents who do <u>not</u> engage in in-stream recreation should be almost purely intrinsic in nature. In calculating the average WTP amount for the non-recreator's alone, therefore, we get an approximation of the intrinsic value o water quality. By subtracting the non-recreator's WTP amount from the total the recreators are willing to pay, we can estimate, in a rough way, the portion of the recreator's benefits which are attributable to intrinsic values.

Of the 832 respondents for whom we have use and WTP data, 323 or 39 percent reported that they had not boated, fished or swum in freshwater in the past two years. These non-users gave a mean WTP amount for fishable water (level C) of $111. Bearing in mind the crudity of our use measurement (which we will discuss later) $111 may be regarded as an estimate of the mean intrinsic value which fishable level water quality nationwide has for our sample. The mean WTP amount given by the users (61 percent of our sample) was $237. By assuming that users value the intrinsic benefits of freshwater at the same level as the non-users, we can subtract $111 from $237 to arrive at a mean recreational benefit of $126 for the users. By these calculations, intrinsic benefits are large; comprising/about 45 percent of the benefits for each user ($111/237);100 percent of the benefits for the non-users ($111/S111); and/about 55 percent of the total mean benefit for the sample as a whole ($111/$194)[8].

An alternative way to estimate intrinsic benefits is to estimate equation 7.

Eq. 7: $WTP_{Total} = WTP_{Intrinsic} + WTP_{Recreation}$

This may be done by regressing USERD on the WTP amount for fishable water. Table 5.7 gives the results. Both the intercept and the USERD terms are highly significant. The coefficient of the intercept may be interpreted as the intrinsic value. This amount, $113, is very close to the $111 arrived at by the other method.

In an effort to see whether it is possible to gain insight into the differential contribution to the equation of the three types of freshwater use which comprise the USERD variable, we estimated equation 8 (Table 5.8).

[8] From Table 5.1.

Table 5.7 USER OLS INTRINSIC BENEFIT ESTIMATE FOR FISHABLE WATER QUALITY

	Coefficient	t
Intercept	112.6	7.7
USERD	131.7	7.0

N = 794

R^2 = .06

F = 49.0

USERD = Dummy variable where 1 = personal use of freshwater for fishing, boating, or swimming in the past two years.

Table 5.8

BOAT, SWIM, FISH OLS
INTRINSIC BENEFIT ESTIMATE
FOR FISHABLE WATER QUALITY

Eq. 8	Coefficient	t
Intercept	120.1	9.3
BOAT	93.8	4.4
FISH	22.5	1.1
SWIM	75.4	3.6

N = 792

R^2 = .08

F 22.1

BOAT = Dummy variable where 1 = boated on freshwater in last two years.

FISH = Dummy variable where 1 = fished in freshwater in last two years.

SWIM = Dummy variable where 1 = swam in freshwater in last two years.

Collinearity between boating, fishing, and swimming precludes making firm estimates of the size and significance of the coefficients on boating, fishing and swimming, so we will only highlight major differences between the types of recreation.[9] The intrinsic term (intercept) remains stable and gains in significance. However, only two of the three types of uses, boating and swimming, have significant t values. Fishing is not a good predictor of the respondent's value for fishable water, an anomaly which is not easy to interpret. On the hypothesis that there may be an interaction between fishing and income which depresses the effect of fishing use in an equation which includes people from all income levels, we reestimated equation 8 for each of our four income levels. According to the t statistics for this new estimation, which are shown in Table 5.9, fishing continues to be non-significant. A more detailed analysis of this question, which we have not undertaken at this point, may provide clues to why fishing is unrelated to people's value for national water quality at the fishable level.

Table 5.9 also shows some interesting findings with respect to the other two recreation variables and the USERD measures. At the lower income levels, boating and swimming have significant t values whereas at the higher two levels (with the exception of swimming for the highest income level) the values are not significant. Likewise, USERD is strongly

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[9] It may be possible to use ridge regression to arrive at more accurate parameter estimates.

Table 5.9 t RATIOS FOR REGRESSION OF USE ON WILLINGNESS TO PAY FOR FISHABLE WATER (C)[1] HOLDING INCOME CONSTANT

	Income Level	USERD	/	Recreational Use of Water in last two years: BOAT	FISH	SWIM	R^2 for BOAT + SWIM + FISH (Eq. 8)
I.	$0 - 9,999	5.3		2.6	.03	2.7	.16
II.	$10,000 - 14,999	4.8		2.0	1.5	3.0	.21
III.	$15,000 - 24,999	1.9		1.4	1.3	.6	.03
IV.	$25,000 and over	1.8		.8	.5	2.7	.07

Underlined t values are significant at $\geq$ .05.

[1]Using equation 8, Table 5.8.

significant for income levels I and II and barely significant for III and IV. This suggests that recreational use is an important determinant of the value lower income people have for water quality, This is confirmed by the R^2s of .15 and .21 for these regressions (equation 8, for income levels I and II on WTP for fishable quality water). Using our regression estimation technique described earlier, we calculated the intrinsic benefits for each of the four income groups. Table 5.10 gives the results which show the dominance of recreational benefits for the people in the lower income categories. Only one-third of the WTP amounts expressed by those in income levels I and II may be attributed to intrinsic benefits by our technique. For the two higher income groups almost three-fourths of the benefits are shown to be intrinsic.

We are encouraged by these results which suggest this approach to estimating intrinsic benefits is worth pursuing further. In the Conclusion we propose refinements for the questionnaire and in our analytic techniques which will enable us to make reliable intrinsic estimates.

Table 5.10 PERCENTAGE OF FISHABLE WATER QUALITY WTP BENEFITS ESTIMATED AS INTRINSIC BY INCOME LEVEL[1]

Income Level	Benefits: Intrinsic	Benefits: User	Benefits: Total	Intrinsic Benefits as Percent of Total Benefits
I. $0 - 9,999	$30	$172	$102	29%
II. $10,000 - 14,999	47	125	172	38
III. $15,000 - 24,999	171	64	235	73
IV. $25,000 and over	296	111	407	73

[1] Versions A, B, C combined. Estimated using equation 7 , Table 5.7.

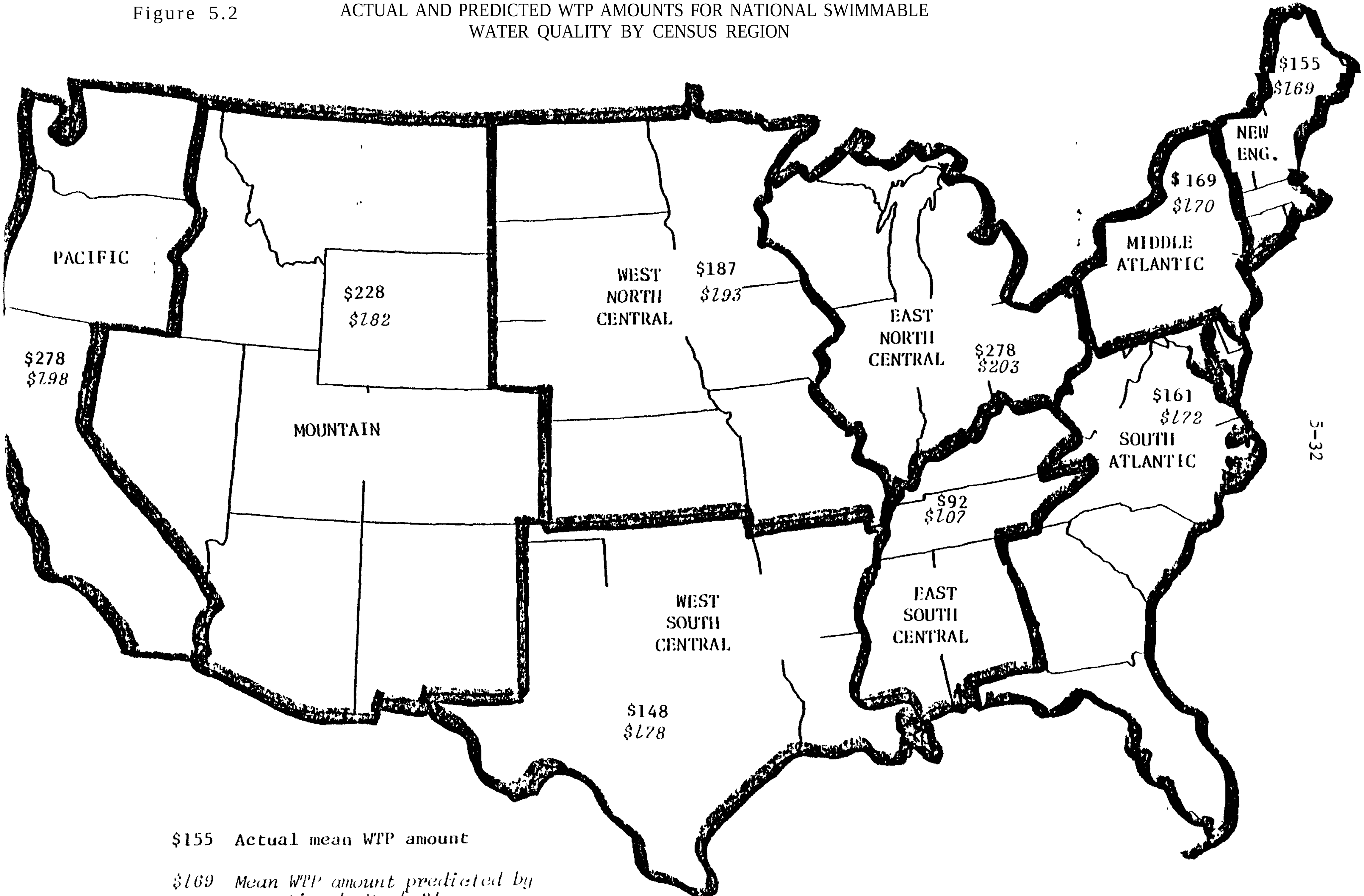
REGIONAL ESTIMATIONS

As a test of the robustness of our estimations we used our final (corrected) regression model (eq. 5, p. 5-21) to predict the regional willingness to pay for national water of fishable quality. To do this we substituted the regional mean value for the variables in equation (5) and calculated a predicted WT amount for each of the nine census regions. The actual WTP amount was calculated for the same regions. The two values are shown on the map in Figure 5.2. For all but two of the regions the fit is very close and confirms the stability of our regression model. Only in the Pacific and the East North Central, the two regions with highest mean WTP amounts, did the predicted amounts differ by more than two standard errors of the mean from the actual. When we estimated equation (5)using dummy variables for eight of the nine regions, the distinctiveness of these regions was confirmed as they were only ones with significant t values. (The coefficients of the model's other variables were not significantly changed in the regional dummy estimation.)

Although the difference between the actual and expected amounts is relatively modest, these results suggest that for these two regions

one or more explanatory factors unique to these regions may be at work in addition to income, education, recreational use, concern about water pollution and environmentalism. However, we know from our analysis of other data in the survey that respondents in these regions do not differ significantly from those in other regions in either their evaluation of the

Figure 5.2 ACTUAL AND PREDICTED WTP AMOUNTS FOR NATIONAL SWIMMABLE WATER QUALITY BY CENSUS REGION



$155 Actual mean WTP amount

$169 Mean WTP amount predicted by equation 5, P. 5-21.

5-32

quality level of the local freshwater or in their perception of the change in quality of freshwater in their locality during the past five years. Possibly the presence of the Great Lakes and the abundant freshwater resources in the Michigan penninsula and Wisconsin and the equally unique water resources of the California and the Pacific Northwest give water quality a greater salience for the residents of these areas which translates into these higher values.

In the next chapter we propose a technique by which our regional models may be used to estimate water quality benefits for small geographical areas.

Chapter 6

CONCLUSION AND RECOMMENDATIONS

In this study we have developed and tested a macro WTP method for valuing the benefits of national water quality. The advantage of this method is the ease by which benefits can be reliably aggregated to the sampling frame, in our case the nation. With one exception the method was shown to be resistant to the several biases which threaten WTP studies. In the course of this study we also addressed a number of theoretical and methodological issues including the types of water quality benefits, the role of implied property rights in WTP surveys, the appropriate consumer surplus measures to use in WTP studies, the relationship between strategic and hypothetic bias, the appropriate model for estimating WTP equations, how to correct for heteroskedasticity where the independent variables include both continuous and dummy variables, and how to measure the intrinsic values of water quality.

Although our WTP instrument measures a wide range of water quality benefits which accrue to individual citizens, it does not measure all such benefits. Water pollution is not described as irreversible in our contingent market, so possible long term personal option or intergenerational option benefits (e.g. from the avoidance of contamination of water bodies by certain toxic chemicals) are not included. Neither are possible drinking water benefits.

One principle we followed in designing our instrument was to enhance the credibility of the estimates by adopting conservative procedures whenever possible. For example, given a choice between monthly payments or an annual payment we chose the latter

Table 6.1 DIRECTION OF BIASES IN THE RFF SURVEY

Type of Potential Bias	Direction of Probable Bias			
	Upward	Downward	Intermediate	None
<u>Survey Context and Construction</u>				
External Political Context		?X		
Environmental Trade-off Questions		X		
Vehicle (Taxes and Prices)		?X		
Payment Schedule (Yearly)		?X		
Implicit - No Permanent Pollution Damage		X		
Zero Encouragement		X		
Different Payment Cards				X
Interviewer Effects			X	
<u>Response</u>				
Inclusion of Protest Zero's	X	X		
<u>Traditional Biases</u>				
Strategic			?X	
Hypothetic	?X			
<u>Estimation Techniques</u>				
Maximum Amount Constrained at $999		x		
Substituting amount from lower level if amount for level being analyzed missing		X		
Intrinsic Estimation Procedure		X		

? indicates uncertainty about whether or not the bias is present. If present, it is in the direction shown.

on the grounds that it showed the respondent the full magnitude of his or her value for water quality whereas monthly payments might have induced an "easy payment plan" mentality. Table 6.l summarizes the probable biasing effect of the present instrument's components, the response pattern, and our analytic procedures. The rationale for our judgments are contained in the preceeding chapters, especially Chapter 4.

With the exception of the item nonresponse problem, our goal of creating a WTP instrument which is reliable and credible was largely fulfilled in this study. Despite our conservatism in avoiding instrument and procedural factors which might bias the results upwards, respondents express sizable value for clean water. A large fraction of this value comes from the intrinsic benefits of water quality. Yet our illustrative estimates clearly suggest that the incremental benefits, as measured by the WTP methodology, decrease as the level of water quality being evaluated increases.

In what follows, we outline the modifications in wording, procedure and analytic techniques which we have identified on the basis of this experiment as necessary for a successful use of the instrument in a full scale national water benefits survey. We are confident that these modifications will overcome. the item nonresponse problem and improve the other, lesser, weaknesses in the present form of the instrument. We also discuss how the instrument can be used to derive sub-national estimates and to value other forms of national water quality.

Overcoming Item Nonresponse Bias

Earlier in this report we identified item nonresponse bias (including in this discussion both nonresponse and zero bids) as the major problem with our survey. Some item nonresonse is inevitable, of course. In Chapter 4 we argue that WTP surveys are sufficiently demanding that somewhat higher item nonresponse rates than normal are to be expected (e.g. 10-20 percent range) for national probability surveys and that such item nonresponse

(continue)

rates are tolerable. In our experimental test the interviewers did not receive special instructions nor did they have the opportunity to have their questions answered by the researchers. Moreover, the water benefits vehicle was added on to an existing survey instead of comprising a survey in its own right. We believe these are the major reasons for the high item nonresponse rate. The following measures are designed to reduce the item nonresponse bias to manageable proportions:

A. Field Work Procedures

1. A pre-test should be conducted with the revised instrument using several of the survey research organization's interviewers to interview approximately 50-100 people. The interviewers would probe all item nonresponses and zero bids to ascertain the reasons why these were given. Following the pre-test the interviewers would be debriefed at length.

2. On the basis of the pre-test, detailed instructions for the interviewers would be prepared. These would explain the study's procedures to the approximately 100 interviewers who will do the final interviewing.

3. Since the interviewers for a national survey are scattered across the country, there is no easy way to brief them personally. It is possible, however, to call each of them by phone after they

have received the instructional materials, but prior to the interviewing, to answer their questions. The interviewers can also be encouraged to call the researchers collect if they have substantive questions about the instrument which arise during the course of the interviewing.

B. Questionnaire Modifications

1. At key points in the description of the contingent market, the questionnaire/should instruct the interviewer to pause and ask the respondent "Is that clear?" "DO you have any questions?" This will encourage respondents to obtain clarification and maintain an active interest in the interview. The interviewer will be supplied with a set of standard answers to the questions which were most commonly raised in the pre-test.

C. Aggregation Procedures

If the national survey sample (e.g. N=2000) is sufficiently large, weighting procedures can be used to correct for the biases introduced by item nonresponse. Such procedures are routinely used by survey research organizations to correct for sample nonresponse. They involve the identification of the relevant underrepresented respondent characteristics (e.g. old, black) and the weighting of those who did give responses so that these respondents will more accurately represent the full sample (e.g. old blacks would receive specified weight greater than one, young whites would receive a weight less than one, etc.).[1]

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[1]Holt, et al., in a recent article (1980) discuss the implications of using sample survey data in regression analysis when the sample represents an unequal probability sample. They warn that the bias in the OLS estimator *b* can be large under these circumstances. On the basis of simulations they recommend a *p*-weighted procedure for most situations involving unequal probability sample data. Although our original sample is an equal probability sample, because of the item non-response problem our effective sample for estimating the WTP amounts is of the unequal probability variety. We do not use their procedure for our data here because we are not trying to make national estimates at this point. In a subsequent survey, however, we would use their technique, if necessary, to correct for item nonresponse.

Intrinsic Benefit Estimate

We are encouraged by the test of our procedure for separating intrinsic and recreational benefits. Further refinements are necessary, however, before we can reliably estimate intrinsic benefits from macro WTP data on water quality. 1) Because of space limitations in our questionnaire, we limited our use questions to the respondents' own experience. But our unit of analysis is the household, not the individual respondent. Someone who does not use freshwater directly,but who is married to someone who does, may value fresh-water quality for its contribution to his or her spouse's enjoyment.

2) Our procedure for estimating an intrinsic value for the entire sample is oversimplified. If non-users were randomly distributed among the sample our device of proceeding directly from the mean WTP amount for the non-users to inferring the intrinsic value of a water quality level for the entire sample would be defensible. However, non-users are not so distributed, but are differentially older and black, for example, In general, older people and blacks tend to give lower WTP amounts than younger people and whites. It is necessary, therefore, to devise weighting procedures based on a comparison of the WTP smounts for, say, older users vs. older non-users, to corect for this bias.

3) Households who do not currently use freshwater for recreation should be asked a question about intended future recreational water use. This will provide useful option value information.

4) Questions need to be asked about the availability and use of substitute sources of water for recreation. Respondents who own swimming pools or who belong to swimming clubs may value swimmable freshwater less than those who do not have access to such facilities,

Other Refinements and Techniques

The strong correlation between the regional WTP estimates from our national WTP equation (eq. 5-31-33 above) and the actual regional WTP amounts suggest that a scheme can be devised to estimate water benefits for sub-national geographic areas. Such a scheme would work approximately as follows: 1) A new (presumably more predictive) national benefits equation would be estimated from a large national survey. 2) Census data would be used to supply the area mean values for the demographic variables of the equation (e.g. income, education). 3) A low cost area telephone survey could measure the attitudinal variables for the equation. 4) Local benefits would then be estimated using these data and the coefficients from the national equation. Procedures would have to be devised to determine the correct apportionment of local and national benefits and the appropriate aggregation procedure for people and water bodies. One procedure for the former is to do a pilot regional or local WTP study parallel with the national survey.

In the present study we value a uniform level of national water quality by referring to the "nation's overall water quality at level x where virtually all of it is at least clean enough for x." Our method can be adapted to value alternative supply options such as "all the nation's waterbodies except for x, y, and z" with the respondent being shown a map depciting the probable, location of those waterbodies which would not meet a specified level.

A final refinement, which is applicable to WTP surveys of all kinds, is to ask a series of questions to measure the respondents' firmness of opinion about his or her WTP amount. These questions would show whether or not the contingent market and WTP question sequence create a sufficiently meaningful situation for the respondent. The answers to these items would provide an overall evaluation of the instrument's realism (and of the danger of hypothetic bias). They may also be used to identify individual respondents who, although they gave answers, really did not have sufficiently firm opinions to warrant the inclusion of their responses in the analysis.

The survey research form of Yankelovich, Skelly and White have devised and tested what they call a "mushiness index" which can be adapted to this purpose.[2] According to them: "Answers to survey questions on such issues (ones that are not 'thought through') are often top-of-the-head and subject to change." Mushiness describes the volatility and changeability of the public's views. (Public Opinion, 1981:50). In the RFF instrument we experimented with a single quality check item which is similar

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[2]We recommend including three of the four items in the YSW scale. These measure: 1) the degree of personal involvement in the issue, 2) whether the person feels he or she has enough information about it and 3) the firmness with which the person holds his or her views. The wording is contained in Public Opinion - (1981:50).

to one of the indicators in the Yankelovich, Skelly and White scale. (We were only able to include it in two of the four versions of our questionnaire, A and C). The results of this item, which asked people whether we had supplied them with enough information so that they could decide how much they would be willing to pay for better water quality, were encouraging. Only 12 percent said they did not have "enough (information) at all" while 56 percent said they had "about enough" or "more than enough" (14 percent). Twenty-two percent said they had "not quite enough."

REFERENCES

Alwin, Duane F. 1977. "Making Errors in Surveys, an Overview," Sociological Methods & Research, vol. 6, no. 3, November, pp. 131-150.

Amemiya, Takeshi, 1373. "Regression Analysis When the Dependent Variable is Truncated Normal," Econometrica, vol. 41, pp. 997-1016.

Babbie, Earl R. 1973. Survey Research Methods (Belmont, CA., Wadsworth Publishing Co.).

Backstrom, Charles H. and Gerald D. Hursh. 1963. Survey Research (Evanston, Ill., Northwestern University Press),

Baumol, William J. and Wallace E. Oates, 1979. Economics, Environmental Policy and The Quality of Life

Binkley, Clark S. and W. Michael Hanemann. 1978. "The Recreation and Benefits of Water Quality Improvement: Analysis of Day Trips in An Urban Setting," (Washington, D.C., U.S.E.P.A.).

Bishop, Richard C. and Thomas A. Heberlein, 1980. "Simulated Markets, Hypothetical Markets, and Travel Cost Analysis: Alternative Methods of Estimating Outdoor Recreation Demand," Journal of American Agricultural Economics, December (No. 187, Agricultural Economics Staff Paper Series).

Blank, Frederick M., et al., 1978. "Valuation of Aesthetic Preferences: A Case Study of the Economic Value of Visibility," (paper prepared by Resource and Environmental Economics Laboratory, University of Wyoming, under contract with Electric Power Research Institute, Palo Alot, CA), October 6.

Bohm, Peter, 1979. "Estimating Willingness to Pay: Why and How?" Scandinavian Journal of Economics, vol. 81, no. 2.

Bohm, Peter. 1972. "Estimating Demand for Public Goods: An Experiment," European Economic Review, vol. 3, pp. 111-130.

Bradford, David F. 1970. "Benefit-Cost Analysis and Demand Curves for Public Goods," Kyklos, vol. 23, pp. 775-791.

Brannon, R., et al., 1973. "Attitude and Action: A Field Experiment Joined to a General Population Survey," American Sociological Review, vol. 38, pp. 625-36.

Brookshire, David S., Ralph C. d'Arge, and William D. Schulze, 1979. "Methods Development for Assessing Tradeoffs in Environmental Management," vol. 2, U.S.E.P.A. (available from National Technical Information Service).

_____, Berry C. Ives, and William D. Schulze. 1976. "The Valuation of Aesthetic Preferences," Journal of Environmental Economics and Management," vol. 3, no. 4, pp. 325-346.

_____, Alan Randall and John R. Stoll. 1980. "Valuing Increments and Decrements in Natural Resource Service Flows," American Journal of Agricultural Economics, vol. 62, no. 3, pp. 478-488.

_____, Mark A. Thayer, William D. Schulze and Ralph d'Arge, n.d. "Valuing Public Goods: A Comparison of Survey and Hedonic Approaches," (research funded under grant, Methods Development for Assessing Air Pollution Control Benefits) (U.S.E.P.A.).

Burch, William R., Neil H. Cheek, and Lee Taylor, 1972. Social Behavior, Natural Resources and the Environment (New York, Harper & Rowe).

Burington, Richard Stevens and Donald Curtis May. 1958. Handbook of Probability and Statistics with Tables (Sandusky, Ohio, Handbook Publishers, Inc.).

Cambridge Reports. 1978. "Public and Worker Attitudes Toward Carcinogens and Cancer Risk," (prepared for Shell Oil Company).

Campbell, D.T., C.R. Seigman and M.B. Bees, 1967. "Direction of Wording Effects in the Relationships Between Scales," Psychological Bulletin, no. 68, November, pp. 292-303.

Carr, L. 1971. "The Srole Items and Acquiescence," American Sociological Review, vol. 35, April, pp. 287-293.

Charbonneau, J. John and Michael J. Hay, 1978. "Determinants and Economic Values of Hunting and Fishing," (paper presented at 43rd North American Wildlife and Natural Resources Conference, Phoenix, Arizona, March 18-22).

Cicchetti, Charles J., Anthony C. Fisher and V. Kerry Smith, 1976. "An Econometric Evaluation of a Generalized Consumer Surplus Measure: The Mineral King Controversy," Econometrica, vol. 44, November, pp. 1269-1276.

Cicchetti, Charles J., Robert K. Davis, Steve H. Hanke, Robert H. Haveman, and Jack L. Knetsch. 1972. "Benefits or Costs? An Assessment of the Water Resources Council's Proposed Principles and Standards," (pamphlet available from Department of Geography & Environmental Engineering, Johns Hopkins University).

Cicchetti, Charles J. and A. Myrick Freeman III. 1971. "Option Demand and Consumer's Surplus: Further Comment," Quarterly Journal of Economics vol. 85, no. 3, August, pp. 528-539.

Cohen, A.C. Jr., 1957. "On the Solution of Estimating Equations for Truncated and Censored Samples from Normal Populations," Biometrika, vol. 44, pp. 225-236.

_____, 1950. "Estimating the Mean and Variance of Normal Populations from Singly and Doubly Truncated Samples," Annals of Mathematical Statistics, vol. 21, pp. 557-569.

Couch, A. and K. Keniston, 1960. "Yeasayers and Naysayers: Agreeing Response Set as a Personality Variable," Journal of Abnormal and Social Psychology vol. 60, March, pp. 151-174.

Council on Environmental Quality. 1980. "Public Opinion on Environmental Issues," (Washington, D.C., Council on Environmental Quality).

Crespi, Irving. 1981. "Reporting the Polls" Public Opinion vol. 4, no. 2, April/May, pp. 48-50.

Curie, John Martin, John A. Murphy and Andrew Schmitz. 1971. "The Concept of Economic Surplus and Its Use in Economic Analysis." The Economic Journal, vol. 81, no. 324. December, pp. 741-799.

d'Arge, Ralph, W. Schulze, and D. Brookshire, 1980. "Benefit-Cost Valuation of Long Term Future Effects: The Case of CO_2" (paper prepared for RFF/ National Climate Program Office Workshop, April 24-25, Ft. Lauderdale, Florida).

Darling, Arthur H. 1973. "Measuring Benefits Generated by Urban Water Parks," Land Economics, vol. 49, no. 1, February, pp. 22-34.

David, Elizabeth L. 1971. "Public Perceptions of Water Quality," Water Resources Bulletin, vol. 7, no. 1, June, pp. 453-457.

Davis, Robert K. 1980. "Analysis of the Survey to Determine the Effects of Water Quality on Participation in Recreation," (memorandum to John Parson, National Capital Region, National Park Service, (Washington, D.C., U.S. Department of the Interior) July 28.

_____, 1964. "The Value of Big Game Hunting in a Private Forest," (Transactions of the 29th North American Wildlife and Natural Resources Conference, March), (Washington, D.C., Wildlife Management Institute).

_____, 1963. "Recreation Planning as an Economic Problem," Natural Resources Journal, vol. 3, no. 2, October, pp. 239-249.

Dillman, Don A. 1978. Mail and Telephone Surveys - The Total Design Method, (New York, John Wiley & Sons).

Dohrenwend, B.P. 1966. "Social Status and Psychological Disorder: An Issue of Substance and an Issue of Method," American Sociological Review, vol. 31, February, pp. 14-34.

Dunlap, Riley E. and Kent D. Van Liere. 1978. "Environmental Concern: A Bibliography of Empirical Studies and Brief Appraisal of the Literature," (Monticello, Illinois, Vance Bibliographies).

Dunlap, Thomas R., 1981. DDT: Scientists, Citizens and Public Policy (Princeton, N.J., Princeton University Press).

Dutta, M. 1975. Econometric Method (Cincinnati, Ohio, South-Western Publishing Co.).

Eastman, Clyde, Alan Randall, and Peggy L. Hoffer, 1974, "How Much To Abate Pollution," Public Opinion Quarterly, pp. 575-584.

_____, _____, _____. 1978. "A Socioeconomic Analysis of Environmental Concern: Case of the Four Corners Electric Power Complex," Bulletin 626 Agricultural Experiment Station.

Edwards, A. 1957. The Social Desirability Variable in Personality Assessment and Research, (New York, Dryden).

Federal Energy Administration, 1977. "The Surveys of Public Attitudes and Response to Federal Energy Policy," (data prepared by Opinion Research Corporation; available from Inter-University Consortium for Political and Social Research, Ann Arbor, Michigan).

Feenberg, Daniel and Edwin S. Mills. 1980. Measuring the Benefits of Water Pollution Abatement (New York, Academic Press).

Fischer, David W. 1974. "Willingness to Pay as a Behavioural Criterion for Environmental Decision-Making," Journal of Environmental Management, vol. 3, pp. 29-41.

Fish and Wildlife Service, U.S. Department of Interior. n.d. "1975 National Survey of Hunting, Fishing and Wildlife - Associated Recreation," (Washington, D.C., U.S. Department of Interior).

Free, Lloyd A. and Hadley Cantril. 1967. The Political Beliefs of Americans - A Study of Public Opinion, (New Brunswick, N.J., Rutgers University Press).

Freeman, A. Myrick. 1979a. "The Benefits of Air and Water Pollution Control: A Review and Synthesis of Recent Estimates," (report prepared for Council on Environmental Quality), December.

_____. 1979b. The Benefits of Environmental Improvement - Theory and Practice (Baltimore, Md., Johns Hopkins University Press for Resources for the Future).

Freund, John E. and Ronald E. Walpole. 1980. Mathetmatical Statistics (Englewood Cliffs, N.J., Prentice-Hall).

Fuller, Carol H. 1974. "Weighting to Adjust for Survey Nonresponse," Public Opinion Quarterly vol. 38, no. 2, pp. 239-246.

Glejser, H. 1969. "A New Test for Heteroskedasticity," Journal of the American Statistical Association, vol. 64, pp. 316-323.

Goldberger, Arthur S. 1964. Econometric Theory (New York, John Wiley & Sons).

Goldfeld, S.M. and R.E. Quant, 1972. "Nonlinear Methods in Econometrics," in D.W. Jorgenson and J. Waelbroeck, eds. Contributions to Economic Analysis vol. 77, (Amsterdam, North-Holland).

_____ and _____. 1965. "Some Tests for Homoskedasticity," Journal of the American Statistical Association, vol. 60, pp. 539-47.

Gramlich, Frederick W. 1977. "The Demand for Clean Water: The Case of the Charles River," National Tax Journal, vol. 30, no. 2, June, pp. 183-194.

Greenley, Douglas A., Richard G. Walsh, and Robert A. Young. 1980. "Option Value: Empirical Evidence from a Case Study of Recreation and Water Quality," Quarterly Journal of Economics, forthcoming.

Harris, Louis and Associates. 1969. "A Study of the Attitudes of the American Public Toward Improvement of the Natural Environment," (prepared for the National Wildlife Federation).

Haveman, Robert, 1975. "Discussion of Dennis Tihansky's Paper, 'A Survey Empirical Benefit Studies,"' in Henry M. Peskin and Eugene P. Seskin, eds. Cost Benefit Analysis and Water Pollution Policy (Washington, D.C., The Urban Institute), pp. 166-167.

Hay, Michael J. and Kenneth McConnell, 1979. "An Analysis of Participation in Nonconsumptive Wildlife Recreation," Land Economics vol. 55, November, pp. 460-471.

Henderson, James M. and Richard E. Quant. 1971. Microeconomic Theory: A Mathematical Approach, (New York, McGraw-Hill).

Henry, Claude, 1974. "Option Values in the Economics of Irreplaceable Assets," The Review of Economic Studies Symposium, pp. 89-104.

Hicks, J.R. 1956. A Revision of Demand Theory (Oxford, Clarendon Press).

_____, 1943. "The Four Consumer Surpluses," Review of Economic Studies, vol.11, pp. 31-41.

_____, 1941. "The Rehabilitation of Consumer's Surplus," Review of Economics Studies vol. 8.

_____, 1939. "Foundations of Welfare Economics, "Economic Journal, vol. 43.

Hogg, Robert V. and Allen T. Craig. 1978. Introduction to Mathematical Statistics (New York, MacMillan Publishing Co.).

Holt, D., T.M.F. Smith and P.D. Winter, 1980. "Regression Analysis of Data from Complex Surveys," J.R. Statist. Soc. A 143, part 4, pp. 474-487.

Jackman, M.R. 1973. "Education and Prejudice or Education and Response-set?" American Sociological Review, vol. 38, June, pp. 327-339.

Johnston, J. 1972. Econometric Methods, (New York, McGraw-Hill).

Katona, George, 1980. Essays on Behavioral Economics, (Ann Arbor, Michigan, Survey Research Center, University of Michigan).

Kelly, S. and T.W. Mirer, 1974. "The Simple Act of Voting," American Political Science Review, vol. 68, pp. 572-91.

Kmenta, Jan. 1971. Elements of Econometrics (New York, MacMillan).

Knetsch, Jack L. and Robert K. Davis. 1966. "Comparisons of Methods for Recreation Evaluation," in Allen V. Kneese and Stephen C. Smith, eds, Water-Research (Baltimore, Johns Hopkins University Press), pp. 125-142,

Krutilla, John V. 1967. “Conservation Reconsidered," The American Economic Review, vol. 57, pp. 787-786.

_____ and Anthony C. Fisher, 1975. The Economics of Natural Environments: Studies in the Valuation of Commodity and Amenity Resources, (Baltimore, Johns Hopkins University Press for Resources for the Future).

Kurz, Mordecai. 1974. "Experimental Approach to the Determination of the Determination of the Demand for Public Goods," Journal of Public Economics, vol. 3, pp. 329-348.

Ladd, Everett C. and G. Donald Ferree, 1981. "Were the Pollsters Really Wrong?" Public Opinion, vol.3 no. 6, December/January, pp. 13-20.

Maddala, G.S. 1977. Econometrics (New York, McGraw-Hill).

Maler, Karl-Goran. 1974. Environmental Economics: A Theoretical Inquiry (Baltimore, Johns Hopksins University Press for Resources for the Future).

Malinvaud, E. 1980. Statistical Methods of Econometrics (Amsterdam, North-Holland).

Mishan, E.S. 1976a. Cost Benefit Analysis, 2nd edition (New York, Praeger).

_____, 1976b. "The Use of Compensating and Equivalence Variations in Cost-Benefit Analysis," Economica, vol. 43, pp. 185-97.

_____, 1971. Cost-Benefit Analysis, 1st edition (New York, Praeger).

_____, 1960. "A Survey of Welfare Economics, 1939-1959," Economic Journal, vol. 70, June.

_____, 1947. "Realism and Relevance in Consumer's Surplus," Review of Economics Studies, vol. 15.

Mitchell, Robert Cameron. 1980. "Polling on Nuclear Power: A Critique of the Polls After Three Mile Island," in Albert H. Cantril, ed. Polling on the Issues (Washington, D.C., Seven Locks Press).

Mulligan, Patricia J. 1978. "Willingness to Pay for Decreased Risk From Nuclear Plant Accidents," (Working Paper #43, Center for the Study of Environmental Policy, Pennsylvania State University).

Park, R.E. 1966. "Estimation with Heteroskedastic Error Terms." Econometrica, vol. 34, no. 4, October, p. 888.

Phillips, D.L. and K.J. Clancy, 1970. "Response Bias in Field Studies of Mental Illness," American Sociological Review, vol. 35, June, pp. 503-515.

_____ and _____. 1972. "Some Effects of Social Desirability in Survey Studies," American Journal of Sociology, vol. 77, March, pp. 921-940.

Prais, S.J. and H.S. Houthakker, 1955. The Analysis of Family Budgets (New York, Cambridge University Press).

Rao, C, Radhakrishna, 1973. Linear Statistical Inference and Its Applications (New York, John Wiley & Sons).

Randall, Alan and John R. Stoll. 1980. "Consumer's Surplus in Commodity Space," American Economic Review, vol. 70, no. 3, pp. 449-455.

_____, Berry Ives and Clyde Eastman. 1974. "Bidding Games for Valuation of Aesthetic Environmental Improvements," Journal of Environmental Economics and Management, vol. 1, pp. 132-149.

_____, Orlen Grunewald, Angefos Pagoulatos, Richard Ausness, and Sue Johnson, 1978. "Estimating Environmental Damages from Surface Mining of Coal in Appalachia: A Case Study," (Washington, D.C., U.S.E.P.A.).

_____, _____, _____, _____, and _____. 1978. "Reclaiming Coal Surface Mines in Central Appalachia: A Case Study of the Benefits and Costs." Land Economics, vol. 54, no. 4, November, pp. 472-489.

Rosenbaum, Walter A. 1977. "Slaying Beautiful Hypotheses with Ugly Facts: EPA and the Limits of Public Participation," Journal of Voluntary Action Research, vol. 6, nos. 3-4 (Summer-Fall), pp. 161-174.

Rowe, Robert, Ralph C. d'Arge, and David S. Brookshire, 1979. "An Experiment on the Economic Value of Visibility," (available from Department of Economics, University of Wyoming, Laramie).

_____, _____, and _____. 1979. "Environmental Preferences and Effluent Charges," Progress in Resource Management and Environmental Planning," 2nd vol. forthcoming.

Samuelson, Paul. 1955. "Diagrammatic Exposition of a Theory of Public Expenditure," Revue of Economics and Statistics, vol. 37, pp. 350-356.

_____, 1954. "The Pure Theory of Public Expenditure," The Review of Economics and Statistics, vol. 36, pp. 387-89.

_____, 1947. Foundations of Economic Analysis (New York, Atheneum, 1974).

Schulze, William D., Ralph C. d'Arge, and David Brookshire, 1980, "Valuing Environmental Commodities: Some Recent Experiments," (prepared for U.S.E.P.A.) (available from Department of Economics, University of Wyoming, Laramie).

Schuman, Howard and Michael P. Johnson. 1976. "Attitudes and Behavior," in Alex Inkeles, et al., eds. Annual Review of Sociology, vol. 2, (Palo Alto, Ca., Annual Reviews, Inc.)

Silverburg, Eugene, 1978. The Structure of Economics: A Mathematical Analysis (New York, McGraw Hill).

Smith, V.L. 1977, "The Principle of Unanimity and Voluntary Consent in Social Choice," Journal of Political Economy, vol. 85, no. 6, December. pp. 1125-1139.

Steeh, Charlotte G., 1981. "Trends in Nonresponse Rates, 1952-1979," Public Opinion Quarterly, vol. 45, pp. 40-57.

Stouffer, S.A., et al., 1949. The American Soldier: Combat and Its Aftermath vol. 2, (Princeton, N.J., Princeton University Press).

Sudman, Seymour, 1976. Applied Sampling (New York, Academic Press).

Thayer, Mark A. forthcoming. "Contingent Valuation Techniques for Assessing Environmental Impacts: Further Evidence," Journal of Environmental Economics and Management.

Tihansky, Dennis. 1975. "A Survey of Empirical Benefit Studies," in Henry M. Peskin and Eugene P. Seskin, eds. Cost-Benefit Analysis & Water Pollution Policy, (Washington, D.C., The Urban Institute), pp. 127-172.

U.S. Congress. 1977. "The Federal Water Pollution Control Act (P.L. 92-500) as amended by the Clean Water Act of 1977 in 95th Congress, Serial $95-12 (Washington, D.C., U.S. GPO).

Viladus, Joseph. 1974. "Poll Finds Americans Concerned About Environment," National Journal Reports, vol. 6, pp. 634-635.

_____, 1973. "The American People and Their Environment," vol. 1 (Washington, D.C., U.S.E.P.A.).

Walsh, Richard A., D.A. Greenley, R.A. Young, J.R. McKean, and A.A. Prato. 1978. "Option Values, Preservation Values and Recreational Benefits of Improved Water Quality: A Case Study of the South Platte River Basin, Colorado," (U.S.E.P.A.) (available from NTIS).

Weisbrod, Burton A. 1964. "Collective Consumption Services of Individual-Consumption Goods," Quarterly Journal of Economics, vol. 78, no. 3, August, pp. 471-477,

Williams, William H. 1978. A Sampler on Sampling, (New York, John Wiley and Sons).

Willig, Robert D. 1976. "Consumer's Surplus Without Apology," American Economic Review, vol. 66, no. 4, September, pp. 587-597.

Wyckoff, J.B. 1971. "Measuring Intangible Benefits - Some Needed Research," Water Resources Bulletin, vol. 7, no. 1, February, pp. 11-16.

Appendix I THE RFF RESEARCH INSTRUMENT

Same wording for B + C

NOTE:	INSERT THIS FORM AFTER PAGE 14 OF WHITE "X" QUESTIONNAIRES ONLY AND ASK FOLLOWING Q.79.

80. This last group of questions is about the quality of water in the nation's lakes and streams. Congress passed strict water pollution control laws in 1972 and 1977. As a result many communities have to build and run new modern sewage treatment plants and many industries have to install water pollution control equipment.

Here is a picture of a ladder that shows various levels of the quality of water. (HAND RESPONDENT WATER QUALITY LADDER CARD) Please keep in mind that we are not talking about the drinking water in your home. Nor are we talking about the ocean. We are talking only about freshwater lakes, rivers and streams that people look at and in which they go boating, fishing and swimming.

The top of the ladder stands for the best possible quality of water, that is, the purest spring water. The bottom stands for the worst possible quality of water. Unlike the other ladders we have used in this survey, on this ladder we have marked different levels of the quality of water. For example.... (POINT TO EACH LEVEL: E,D,C AND SO ON, AS YOU READ STATEMENTS BELOW)

> Level E (POINTING) is so polluted that it has oil, raw sewage and other things in it, has no plant or animal life and smells bad
>
> Water at level D is okay for boating but not for fishing or swimming
>
> Level C shows where rivers, lakes and streams are clean enough so that game fish like bass can live in them
>
> Level B shows where the water is clean enough so that people can swim in it safely
>
> And at level A, the quality of the water is so good that it would be possible to drink it directly from a lake or stream if you wanted to

Now let's think about all of the nation's rivers, lakes and streams. Some of them are quite clean and others are more or less polluted. Looking at this ladder, would you say that all but a tiny fraction of the nation's rivers, lakes and streams are at least at level D in the quality of their water today or not?

All but a fraction at level D...	1
Not at level D.................	2
Not sure.......................	3

81. As you know it takes money to clean up our nation's lakes and rivers. Taking that int account, and thinking of overall water quality where all but a tiny fraction of th nation's lakes and rivers are at a particul level, which level of overall water quality do you think the nation should plan to reac within the next five years or so--level E, D, C, B or A?

A.................	1
B.................	2
C.................	3
D.................	4
E.................	5
Depends (vol.).....	6
Other (vol.).......	7
Not sure...........	8

INTERVIEWER: CHECK INCOME IN Q.79 ON PAGE 14 OF MAIN QUESTIONNAIRE. THEN LOOK BELOW TO SEE WHICH SCALE CARD RESPONDENT USES IN QUESTIONS 82 - 84.

- IF LESS THAN $9,999 USE CARD A-I
- IF $10,000 TO $14,999 USE CARD A-II
- IF $15,000 TO $24,999 USE CARD A-III
- IF $25,000 AND ABOVE OR NOT SURE/REFUSED USE CARD A-IV

(OVER)

82. Improving the quality of the nation's water is just one of many things we all have to pay for as taxpayers and and as consumers. That is, the costs of things like improving water quality are paid partly by government out of what we pay in taxes and partly by companies out of what we pay for the things they sell us.

This scale card shows about how much people in your general income category paid in 1979 in taxes and higher prices for things like national defense, roads and highways, public schools and the space program. (HAND RESPONDENT APPROPRIATE SCALE CARD A-I, A-II, A-III, OR A-IV; LET RESPONDENT KEEP WATER QUALITY LADDER CARD)

You will see different amounts of money listed with words like "highways" and "public education" appearing by the amount of money average size households paid for each one last year. "Highways" here refers to the construction and maintenance of all the nation's highways and roads. "Public education" refers to all public elementary and secondary schools but does not include the costs of public universities.

I want to ask you some questions about what amounts of money, if any, you would be willing to pay for varying levels of overall water quality in the nation's lakes, rivers and streams. Please keep in mind that the money would go for sewage treatment plants in communities through various kinds of taxes (such as withholding taxes, sales taxes and sewage fees) and for pollution control equipment the government would require industries to install, thus raising the prices of what they make.

At the present time the average quality of water in the nation's lakes, rivers and streams is at about level D on the ladder. (POINT TO LEVEL D ON WATER QUALITY LADDER CARD) If no more money were spent at all tomorrow on water quality, the overall quality of the nation's lakes and rivers would fall back to about level E. (POINT TO LEVEL E) People have different ideas about how important the quality of lakes, rivers and streams is to them personally. Thinking about your household's annual income and the fact that money spent for one thing can't be spent for another, how much do you think it is worth to you to keep the water quality in the nation from slipping from level D back to level E? That is, which amount on this scale card, or any amount in between, is the most you would be willing to pay in taxes and higher prices each year to keep the nation's overall water quality at level D where virtually all of it is at least clean enough for boating? If it is not worth anything to you, please do not hesitate to say so.

Write in amount: $__________

Depends (vol.)	00X	(ASK 83)
Not sure	00Y	
Not worth anything	001	(SKIP TO 85)

83. As I mentioned earlier, almost all of the rivers and lakes in the United States are at least at level D in water quality. What do you think it is worth to you not only to keep them from becoming more polluted but also to raise their overall quality to level C? That is, including the amount you just gave me, which amount on the scale card is the most you would be willing to pay in taxes and higher prices each year to raise the overall level of water quality from level D to level C where virtually all of it would at least be clean enough for fish like bass to live in?

Write in amount: $__________

Depends (vol.)	00X	(ASK 84)
Not sure	00Y	
Not worth anything	001	(SKIP TO 85)

84. What about getting virtually all of the nation's lakes and rivers up to level B on the ladder? Including the amounts of money you have already given me, which amount on the scale card is the most you would be willing to pay in taxes and higher prices each year to make almost all the nation's lakes, rivers and streams clean enough so that people could swim in them?

Write in amount: $__________

Depends (vol.)	00X
Not sure	00Y
Not worth anything	001

Version A + C only

85. Finally, in terms of your being able to decide exactly how much you, yourself, would be willing to pay as a taxpayer and consumer for better water quality, would you say in the last few questions we gave you more than enough information, about enough information, not quite enough, or not enough information at all?

More than enough	1	Not quite enough	3
About enough	2	Not enough at all	4
		Don't know	5

Name __________

Address __________

____

NOW, RETURN TO PAGE 14 OF MAIN QUESTIONNAIRE AND COMPLETE FACTUAL SECTION.

D

NOTE: INSERT THIS FORM AFTER PAGE 14 OF YELLOW "Y" QUESTIONNAIRES ONLY AND ASK FOLLOWING Q.79.

80. This last group of questions is about the quality of water in the nation's lakes and streams. Congress passed strict water pollution control laws in 1972 and 1977. As a result many communities have to build and run new modern sewage treatment plants and many industries have to install water pollution control equipment.

Here is a picture of a ladder that shows various levels of the quality of water. (HAND RESPONDENT WATER QUALITY LADDER CARD) Please keep in mind that we are not talking about the drinking water in your home. Nor are we talking about the ocean. We are talking only about freshwater lakes, rivers and streams that people look at and in which they go boating, fishing and swimming.

The top of the ladder stands for the best possible quality of water, that is, the purest spring water. The bottom stands for the worst possible quality of water. Unlike the other ladders we have used in this survey, on this ladder we have marked different levels of the quality of water. For example...(POINT TO EACH LEVEL: E,D,C, AND SO ON, AS YOU READ STATEMENTS BELOW)

Level E (POINTING) is so polluted that it has oil, raw sewage and other things in it, has no plant or animal life and smells bad

Water at level D is okay for boating but not for fishing or swimming

Level C shows where rivers, lakes and streams are clean enough so that game fish like bass can live in them

Level B shows where the water is clean enough so that people can swim in it safely

And at level A, the quality of the water is so good that it would be possible to drink it directly from a lake or stream if you wanted to

Now let's think about all of the nation's rivers, lakes and streams. Some of them are quite clean and others are more or less polluted. Looking at this ladder, would you say that all but a tiny fraction of the nation's rivers, lakes and streams are at least at level D in the quality of their water today or not?

All but a fraction at level D..	1
Not at level D................	2
Not sure......................	3

81. As you know it takes money to clean up our nation's lakes and rivers. Taking that into account, and thinking of overall water quality where all but a tiny fraction of the nation's lakes and rivers are at a particular level, which level of overall water quality do you think the nation should plan to reach within the next five years or so--level E, D, C, B, or A?

A..................	1
B..................	2
C..................	3
D..................	4
E..................	5
Depends (vol.)......	6
Other (vol.)........	7
Not sure...........	8

INTERVIEWER: CHECK INCOME IN Q.79 ON PAGE 14 OF MAIN QUESTIONNAIRE. THEN LOOK BELOW TO SEE WHICH SCALE CARD RESPONDENT USES IN QUESTIONS 82 - 84.

IF LESS THAN $9,999 USE CARD D-I

IF $10,000 TO $14,999 USE CARD D-II

IF $15,000 TO $24,999 USE CARD D-III

IF $25,000 AND ABOVE OR NOT SURE/REFUSED USE CARD D-IV

(OVER)