AN EXPERIMENT IN DETERMINING WILLINGNESS TO PAY FOR NATIONAL WATER QUALITY IMPROVEMENTS

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AN EXPERIMENT IN DETERMINING WILLINGNESS TO PAY FOR NATIONAL WATER QUALITY IMPROVEMENTS

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Executive Summary

The purpose of this research is to develop a methodology for using direct interview survey techniques to estimate national benefits from freshwater water quality improvements. In particular, this study has developed a method for estimating the intrinsic benefits of water quality, a class of benefits which include option, existence, and bequest benefits among others. The method also measures consumer recreational benefits, but does not estimate industrial, commercial or drinking water benefits.

To accomplish our purpose we adapted the contingent valuation or willingness-to-pay (WTP) survey method for use in a national survey. We first developed and pre-tested a research instrument which measures how much people are willing to pay each year in taxes and higher prices for national water quality of three levels which we defined as "boatable," "fishable," and "swimmable" (Chapter 3). This instrument was then further tested in a full scale survey where it was administered by professional interviewers to 1576 people comprising a nationwide probability sample. For experimental purposes, four equivalent sub-samples were asked different versions of the instrument. We performed extensive analysis on the resulting data to determine the extent to which the biases associated with WTP surveys were present (Chapter 4). With one exception, the item nonresponse rate, the results are very favorable.

Because the purpose of our empirical work is to test, validate and further develop the methodology, we do not attempt to derive national estimates from these data. We do, however, develop illustrative estimates for our cases which suggest aggregate benefits within the range of current national expenditures on water pollution control (Chapter 5). Our technique for estimating

intrinsic benefits involves identifying those respondents who do not use water for "in-stream" recreation and using their WTP amounts as surrogate for intrinsic benefits, Our calculations, again illustrative rather than definitive, suggest intrinsic benefits comprise roughly 40-60 percent of the overall WTP benefits (Chapter 5).

On the basis of these empirical tests and our concurrent work on several important theoretical and conceptual issues relevant to water benefits analysis (Chapters 1-2), we conclude that the use of a national survey to measure water benefits (including intrinsic) is a feasible undertaking, We specify the changes in our pilot instrument and its administration which will enable it to perform this task at acceptable levels of reliability and validity (Chapter 6).

The following are some of the major findings of this study in more detail:

- In the course of this project a number of theoretical and conceptual problems inherent in the direct interview survey method were clarified and further developed. In particular, work was done on consumer surplus measures (p.1-13ff), property rights (1-21ff) and the classification of different types of benefits resulting from water quality improvements (1-46ff). A number of conceptual problems arose which were closely integrated with the theoretical issues. These revolved around ill-defined property rights and the unworkability of willingness to accept compensation questions, WTA. Our conclusion was that theoretical considerations and survey considerations must both be considered in the design of WTP

instruments. Thanks to the recent work of Randall and Stoll (1980) and Brookshire, et al. (1980), however, we show that any theoretical impurity resulting from the balancing of these two considerations need not bias the results as the correct theoretical measures are derivable from the appropriate survey measures. Our conclusions on this question are summarized in Table 1.3 on p. 1-23.

- The most innovative aspect of this study is the development of a "macro" WTP approach to benefits estimation. Previously, WTP surveys had been used primarily to assess willingness to pay for locally defined goods ("micro"). For reasons specified in the report, water quality benefits lend themselves to macro WTP estimation at the national level, however. Our macro approach represents the first time, to our knowledge, that a national sample was surveyed for benefits estimation purposes on their willingness to pay for a public good. The development of this macro approach required the design of several specialized research instruments such as the water quality ladder (A-II) and non-localized benefits questions.
One clearly advantageous aspect of the macro approach is that, if correct sampling procedures are used, individual willingness to pay for water quality can be directly and reliably aggregated to the national level, The sampling techniques used to accomplish this aggregation were implemented in the survey used in this project and are described in Chapter 4 (4-22ff) and Appendix V.

- Our pretest showed the traditional bidding game format resulted in respondent fatigue and a serious starting point bias problem. To overcome this problem we developed the anchored payment card (3-14ff). To test for bias induced by the payment card, its format was systematically varied and three versions of the instrument were administered to separate sub-samples. As this experiment showed no evidence of bias, the payment card is a promising technique for WTP studies which wish to avoid the bidding game format.
- Strategic and hypothetic biases are of concern to economists who desire to use benefits derived from willingness-to-pay surveys. Our major conclusion here is that strategic and hypothetic are not opposite sides of the same bias as had commonly been assumed in the WTP literature, but comprise two separate and distinct potential biases. Table 4.3 on p. 4-22 shows the relationship of the two biases and which WTP question characteristics are necessary to minimize their effects. We further suggest and apply to our data several tests for the presence of strategic and hypothetic biases. These tests suggest that strategic bias is not a problem in our study. Our findings with respect to hypothetic are mixed because of an item nonresponse problem. However, regression equations estimated in Chapter 5 strongly suggest that those respondents who did answer the WTP items did not do so in a random fashion; one of the requirements for the absence of hypothetic biases.

- The item nonresponse problem consists of a high level of no response to the WTP questions (38 percent) and a relatively high level of zero amounts (16 percent). This problem may be attributed to the circumstances of the interviews (it was not possible to provide the interviewers with special training or instructions for this test as would be the case in a full scale implementation of the method and the WTP questions were asked after respondents had answered a half hour's worth of questions for another study) and the question wording (a too strong incentive was offered to the respondents to say water quality wasn't worth anything to them) (4-49ff). Improvements in the method,as suggested in Chapter 6, should reduce this problem to manageable proportions. Recommendations are made for weighting procedures (6-6) which can adjust for the remaining missing data.
- In order for WTP benefit estimates to be credible, a theoretically sound predictive model must be constructed and tested, We have hypothesized the primary determinants of willingness to pay amounts for water quality to be: income, water use, and environmental attitudes. To measure these and several secondary determinants, we chose items from the long environmental survey which preceded the WTP survey. Econometric estimation of this model (5-15ff) strongly supports our theory, The estimates are robust and highly significant (Table 5.5, p.5-21). A special test for heteroskedasticity appropriate for equations with both interval and dummy data was developed for this estimation and successfully implemented (Appendix VIII).

Preface

This study represents one product of several which Resources for the Future has prepared under a Cooperative Agreement with the United States Environmental Protection Agency for "Methods Development for Assessing Economic Benefits of Water Pollution Water." The particular methodological approach which we adopt in this report, a macro willingness to pay survey, emerged as we studied the problem. It builds on a tradition of innovative research using the willingness to pay methodology which extends back to the 1960s and which has flourished during the 1970s as economists have grappled with the challenging task of measuring benefits. Our use of the method diverges from this young tradition in several important respects, however, and in this sense is innovative and experimental. In the course of changing our methodology we also have found it necessary to address a number of generic methodological, conceptual and theoretical issues pertaining to benefits estimation. The fruits of our thinking on these issues is also contained in this report. In this area, too, we are building on the work of our predecessors.

To state a truism: benefits estimation is a difficult and challenging enterprise. Several years ago, Robert Haveman, commenting on a paper which analyzed 60 benefit studies, declared: "To me, the situation is ... extremely discouraging, because, in my view, what has passed for benefit estimates in these studies forms a catalog of what not to do in cost-benefit analysis" (Haveman, 1975). In our endeavor to avoid joining this infamous roll of abortive or misguided benefit studies we hewed as close

as possible to the six methodological criteria set forth by A. Myrick Freeman III in The Benefits of Environmental Improvement (1979a;10-12) and to his dicta:

> Part of the art of benefit analysis involves sensitivity to the gap between the ideal and the available and knowing how much confidence to place in the estimates being generated. (1979a;13).

To help the reader to evaluate the extent to which we have succeeded in this task we provide as much information as possible in this report about the possible biases in our method and how we have tried to overcome them. In the case of the major problem which we encountered, item nonresponse, we describe in detail the procedures which we believe can resolve the problem in a future application of the method.

The structure of our report follows from this approach. In the first two chapters we discuss crucial theoretical and conceptual matters. Chapter 3 describes our research instrument. The next chapter describes the potential biases which threaten the validity and reliability of our findings and our success in dealing with the problems they present. Finally, in Chapter 5 we present our findings. Ever mindful that benefit estimates take on a life of their own, however weak their methodological and conceptual basis may be, we offer our findings only for what they are: experimental data to test a method. Our findings are suggestive, but only a full scale application of a revised instrument can produce estimates of sufficient reliability to use for policy purposes. The final chapter discusses the nature of the revisions we propose.

With the necessary disclaimer that we alone are responsible for the work reported here, we wish to gratefully acknowledge the assistance of our colleagues here at RFF and elsewhere. We have benefitted from discussions with Ralph d'Arge and David Brookshire of the University of Wyoming, George Tolley of the University of Chicago, Alan Randall of the University of Kentucky (while on leave at Chicago) and Alan Carlin, our project monitor at EPA. At RFF, Raymond Kopp and Michael Hazilla offered us much useful counsel on statistical and econometric problems as has William J. Vaughan. Vaughan also prepared our water quality ladder, helped us refine our theoretical and conceptual ideas and collaborated with Carson on a much needed constructive test for heteroskedasticity. Clifford S. Russell was extremely generous with his time and skillful, as always in raising awkward questions and wielding an editor's pen.

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Chapter 1

THE WILLINGNESS TO PAY METHOD, CONSUMER SURPLUS AND WATER QUALITY BENEFITS

In valuing environmental amenities, benefit-cost analysts try to ascertain what individuals would be willing to pay and/or would have to be paid for a particular public investment in a world where markets were pervasive. In such a world the prices for marketed goods would convey information sufficient to ascertain what "the gainers and losers from some public investment will consider equivalent in value to their respective gains and losses" (Brookshire, et al., 1979:33). Since a world like this does not exist for public goods such as the quality of the nation's freshwater streams, rivers and lakes -- the subject of this report -- the shape of the demand curves for these goods cannot be determined directly and economists have been forced to develop techniques to infer the value of these goods. According to Freeman (1979:4) there are three approaches to determining the values individuals place on improvements in environmental quality when markets fail or are nonexistent: (1) holding a referendum on proposals for alternative provisions of environmental quality, (2) using market data for substitutes or complements of the environmental quality being studied in order to determine the demand curve for the environmental quality, and (3) direct questioning of individuals about the value of environmental quality to them personally. The first method, referendums, have not been used in determining national policy on any environmental quality issues and few legislatures run on platforms of specific provision of an environmental amenity.

The second method is the determination of the demand curve for environmental quality indirectly through its relationship with a market good. This technique has been used extensively, particularly in the area of recreation. Examples of the indirect estimation technique include: (1) the determination of substitutability in household production functions,

(2) the travel cost method which assumes that a complementary position exists between travel cost and enjoyment of environmental quality and (3) hedonic pricing which assumes that environmental quality is not a pure public good and that a consumer can substitute (trade) market goods to obtain more or less of the environmental amenity. (Property values are usually used).

Each of these three methods of using market generated data has limitations[1] which are unique to the method. In addition they all suffer from the common inability to estimate the demand for benefits which are strongly separable in utility functions,[2] a characteristic which severely limits their utility for water benefit estimations. Freeman (1979a), for example, suggests that environmental amenities which are not directly associated with private good consumptions are separable from a utility function standpoint. Existence value certainly meets this criteria and thus is probably a separable component of a consumer's utility function, Cicchetti and Freeman (1971) argue that some forms of option value are probably strongly separable. Hence most of the water pollution control benefits we will later define as "intrinsic" and which are a primary subject of this report are not capable of being estimated by means of these techniques.

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[1] See Brookshire, et al. (1979), Freeman (1979a) and Feenberg and Mills (1980) For critiques.

[2] Strongly separable utility functions take the form:

$$U = V[U^1(X) + U^2(Y) + U^3(Q)]$$

where X and Y are subsets of marketable goods and Q is the public good. Changes in Q have no effect on the marginal rates of substitution of any of the marketable goods. For a discussion of separability condition in utility functions with respect to public goods see Freeman (1979a:70-78) or Mahler (1974).

The third approach,which is the one employed in this study, uses the direct technique of asking people in surveys what they are willing to pay or to accept for specified levels of the public good. The use of surveys, as Brookshire, et al. have argued at length, allows the analyst to shortcut the problems inherent in the indirect method by "positing a world of pervasive markets in a form totally consistent with theoretical models of valuation for public goods" (1979:28). Most uses of the WTP method,[3] including ours, limit themselves to hypothetical markets where no money or goods actually change hands. In a couple of intriguing instances, however, researchers have used the method in the context of a simulated market. One case involved subjects paying the amount they bid to see a closed circuit TV program (Bohm, 1972); the other one measured hunters' willingness to accept money for Canadian geese hunting permits by paying them the amounts they were willing to accept in exchange for a surrender of the permit (Bishop and Heberlein, 1980). The simulated market technique has little applicability to most environmental goods because it requires exclusion from the benefit (not seeing the TV program; surrendering the hunting license), a situation which is inconsistent with how public goods such as air and water are actually provided or how it is possible to provide them in an experimental situation,

[3]We use WTP for convenience, as the method properly refers both to people's willingness to pay (WTP) for a public good or their willingness to accept (WTA) compensation for the imposition of a public bad.

This Study

The objectives of this study are to design and validate a method which can: 1) measure the national benefits of freshwater water pollution control to consumers and 2) determine what portion of these benefits come from in-stream recreational values (e.g. boating, fishing) and what portion from the intrinsic or non in-stream recreational values (existence, option, aesthetic, etc.). Very little empirical work has been done on the latter objective and no previous study has measured the former using the WTP method. Our method employs a questionnaire to ask a national sample what they are willing to pay for national[4] water quality of specified levels: boatable, fishable and swimmable.

We adopt the willingness to pay method because it is the only one of the three valuation methods which can be used to estimate intrinsic benefits. It has the significant added advantage that willingness to pay results obtained for a national probability sample of respondents may be straightforwardly blown up to give national benefit estimates. Studies using an indirect method, when based on specific sites, present a problem in this regard, for aggregation from single, or even a few, sites to the nation as a whole involves problems of definition and computation. (See, for example, the companion report by Vaughan and Russell under this cooperative agreement.) This method is not without its problems too, which we will discuss at considerable length insubsequent chapters. For

[4] All the previous uses of the WTP method to estimate the benefits of environmental public goods were limited to local or regional studies. For reasons we will discuss in subsequent chapters, the characteristics of national water quality and its benefits are such as to make a national WTP survey a feasible and desirable undertaking.

the moment we should simply note that the methodological requirements for a successful WTP survey are formidable. Not only must the instrument describe the hypothetical market in a manner which meets the requirements of economic theory, it should also be understandable to respondents with less than a high school education. The sampling and field work must meet high standards, and the sample size should be large enough to permit reliable estimates. The fit between the respondent's experiences and the hypothetical situations described in the questions must be close enough to render the situations meaningful to the respondents.

In this chapter we discuss briefly the willingness to pay method of benefits in the context of economic theory and of the types/which accrue from water pollution control. Our purpose is to clarify the theoretical basis for our measurements and to review the literature on intrinsic water benefits.

Benefit-Cost Analysis

The purpose of this study is to estimate certain benefits resulting from raising the ambient level of fresh water quality in the United States. These benefits are one side of a benefit-cost analysis and may be defined in terms of the (Hicks-Kaldor) Pareto optimality conditions (Mishan, 1976a)[5] which allow for the possibility that those who gain in utility by a change in state can compensate those who lose utility as a result of the change. In our case,where water quality is assumed to be a normal good, benefits are the largest amount of the numeraire the individual is willing to pay to obtain a given higher level of water quality, while costs are the smallest amount that those producing the water pollution are willing to accept for reducing their pollution enough to achieve the specified level of water quality. This can be expressed in terms of utility for consumers and producers.

$U(W^{o},Y) = U(W^{+},Y - B)$ for consumers

$U(W^{o},Y) = U(W^{+}, Y + C)$ for producers[6]

where

W^{o} = the initial provision of good W

W^{+} = a higher level provision of good W

Y = income or all other goods (numeraire)

B = the amount of Y consumers are willing to pay to obtain W^{+}

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[5] Benefit-cost analysis has long recognized that decision makers should consider criteria other than economic efficiency in implementing a policy, in particular distributional issues. These criteria are not considered in this study. For a discussion, see Mishan, 1976a.

[6] Since this is a study of benefits rather than cost we will not consider production cost and producers surplus and their associated problems (See Mishan, 1976a).

C = the smallest amount of compensation that producers are willing to accept to reduce their pollution enough to achieve W+

These definitions can be seen to be those of the Hicksian (1956) compensating measure of consumer surplus, a topic which we will shortly address at greater length. Following Mishan (1976a, 1976b) we assign a minus sign to cost and a plus sign to benefits and aggregate over consumers and producers, The standard benefit-cost equations for a change from one state to another can be expressed in terms of the Hicksian compensation measure as follows:

(1) $\Sigma B^c - \Sigma C^c > 0 \simeq \Sigma CM > 0$

(2) $\Sigma B^c - \Sigma C^c < 0 \simeq \Sigma CM < 0$

(3) $\Sigma B^c - \Sigma C^c = 0 \simeq \Sigma CM = 0$

Where

B^c = Total benefits of the proposed change

C^c = Total costs of the proposed change

CM = Hicksian compensation measure

The discussion thus far has been deceptively simple. We now need to address the complications which arise from the special characteristics of public goods, the nature of public policy, and the limitations of the survey WTP method. These matters are a necessary background to the resolution of the debate over exactly which consumer surplus measure is most appropriate for measuring the benefits of environmental amenities.

Public Goods and Public Policy

Public goods such as national levels of water quality are those which once produced can be supplied to everyone at zero marginal cost and whose enjoyment by one person does not interfere with the enjoyment of another. Furthermore, individuals cannot easily be excluded from enjoying the benefits of the public good, once it is produced. These goods are normally produced as a result of government action, either by government requiring firms or individuals to produce the goods or by government directly subsidizing this production from tax revenues. Once produced, public goods are usually provided free. In the case of water quality Congress declared its intent in the Federal Water Polltuion Control Act (1972) that all freshwater bodies reach fishable and swimmable quality by 1983. Private firms now have to clean their water discharges to meet government regulations, and the federal government subsidizes the major portion of a waste water treatment plant construction program for local governments.

For goods which are provided through markets, individuals are always free to optimize by trading along their budget lines in order to reach the highest indifference curve possible. In this situation, measuring the consumer surplus is a straightforward problem. This is not the case for national water quality, however. First, since "clean water" is a public good, it is provided free to citizen consumers who wish to boat, fish, water ski or simply contemplate it. As such it is available at any given time only at the quality level provided by government policy irrespective of whether some consumers are willing to pay more for higher water quality. In the case of national freshwater this quality level consists of two

factors: a) the ambient quality level (boatable, fishable, swimmable, etc.) and b) the amount of the overall stock of freshwater which is mandated to reach a specified quality level, Thus if the government had set a boatable water quality standard for all freshwater, those who wished to have a higher standard for the nation's water (e.g. fishable) would have no way to obtain it short of changing government policy.[7] Even if this were not the case, it would still make no sense to use survey techniques to ask consumers how much they were willinging to pay for the quantity and quality of national freshwater they regard as personally optimal. Let us say person A might be willing to pay $339 a year for national water of fishable quality and person B $400 for boatable quality water. Once having obtained data in this form, however, it is impossible to aggregate the WTP amounts to get a national benefit estimate for any water quality but the highest/level for which WTP amounts are available. That is, we can reasonably count B's amount for boatable water as the amount which he would also be willing to pay for the higher, fishable, level which A

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[7] This is an oversimplification, of course. Many public goods, fresh water included, are also available privately at a cost. Naturally, national water quality of a certain level can only be provided by the government. But a consumer faced with the absence of public lakes and streams of fishable water quality in his or her locality may be able to obtain access to private water of that quality for a fee of some kind. The existence of numerous private swimming pools, clubs and beaches attests to the widespread use of privately supplied water for swimming, The availability and desirability of these optional sources of water presumably influence the value people place on the public supply of freshwater.

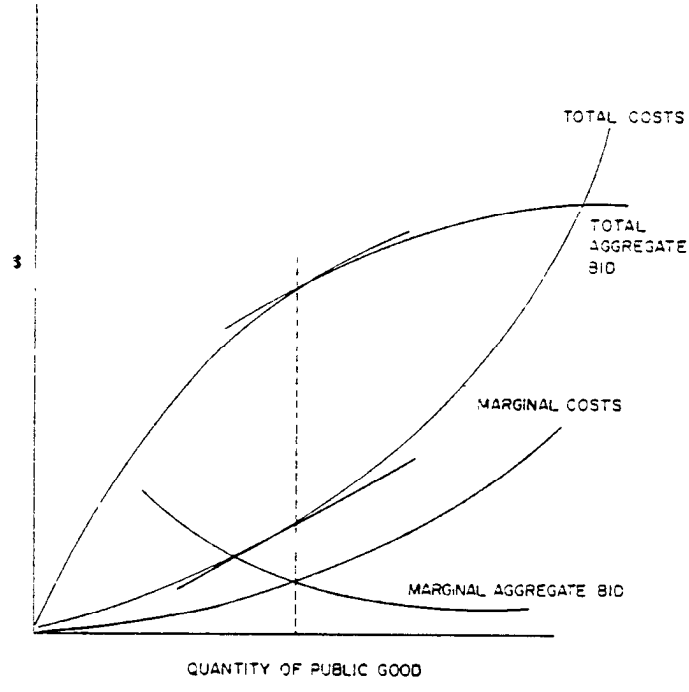
regards as optimal, giving a total WTP amount of $739 for fishable water. We cannot, however, reverse the process and determine what A would be willing to pay for any level of water quality below his optimum. He might be willing to pay most of his $339 for water of boatable quality or he might not be willing to pay anything for water of such inferior quality,

The irrevelance of the consumer's willingness to pay for his or her optimal personal provision of the public good greatly limits the range of consumer surplus measures which are appropriate for the study of national water benefits. David Bradford (1970), in an expansion of Samuelson's (1954) early demonstration that the demand for a public good is the vertical summation of individual demand curves, takes these factors into account in developing his theoretical framework for the valuation of public goods in benefit-cost analysis. This framework and its subsequent expansion by Randall, Ives and Eastman (1974) has been the theoretical basis for most of the WTP surveys. Bradford makes the assumption that individuals choose between various bundles of goods which may differ in quantity and quality and proposes the concept of an aggregate bid/benefit curve (more recently referred to as the total value curve) which he defines as the vertical summation of the individual bid curves. Because of this assumption, Bradford was able to demonstrate that over any relevant range, the aggregate bid curve and its corresponding marginal bid curve (demand curve) need not be continuous or downward sloping. If the aggregate cost is known and the marginal cost curve is derivable, the Bradford framework

resembles the traditional profit maximization framework with the optimal production occurring where the marginal aggregate bid curve and the marginal aggregate cost curve intersect (See Figure 1.1). What is being optimized here is total welfare or utility rather than profits. This intersection can be shown to be the point where the rate of commodity substitution equals the rate of technical substitution which is the traditional welfare economics position necessary for Pareto optimality (Bradford, 1970; Henderson & Quant, 1971). Consumer surplus is usually used as the measure of the aggregate benefit curve.

This caveat should be added. If a unidimensional scale (underlying metric) is unknown or does not exist, it will be impossible to estimate the demand or supply curves for the public good. This means that only specific levels of production can be compared with the initial level or with other specified levels. This is, however, not as serious a problem as it might appear since policymakers almost always choose between a limited number of alternative policies, the benefits of which can be measured in the framework we present.

Figure 1.1 COLLECTIVE OPTIMIZATION OF THE QUANTITY OF PUBLIC GOOD PROVIDED*



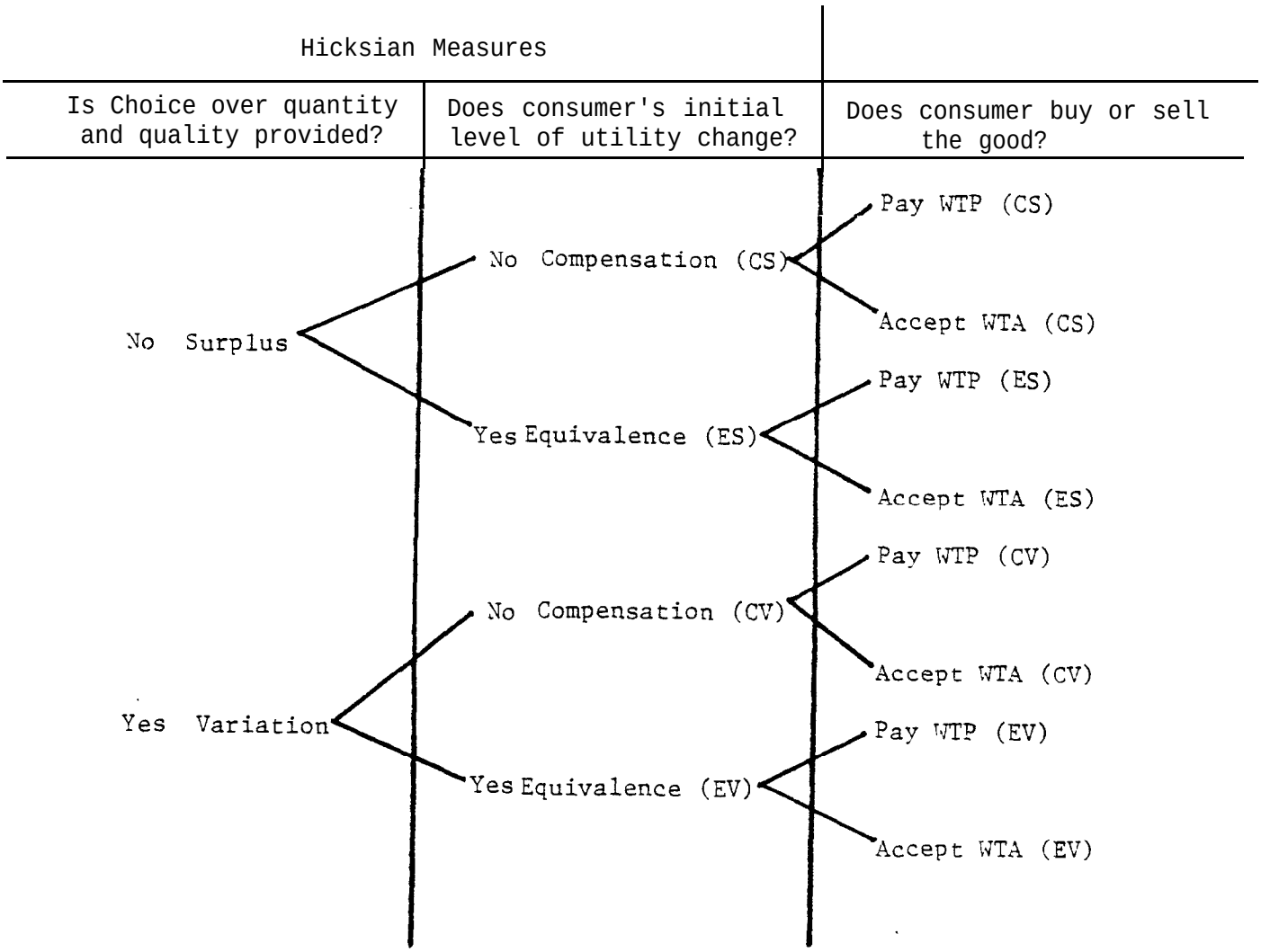
*From Randall, Ives and Eastman (1974).

Consumer Surplus

The concept of consumer surplus has been the subject of considerable debate among economic theorists (Curie, et al., 1971) and among those who use the concept i benefit-cost analysis it has been the subject of some confusion until recently. Consumer surplus was at the center of the welfare economics of Marshall and Pigou. After a period of neglect, it became a point of contention between two eminent theoretical economists; Paul Samuelson and John Hicks. Samuelson (1947) argued that consumer surplus was a subject of "historical and doctrinal interest, with a limited amount of appeal as a mathematical puzzle," a view echoed more recently by Silverberg (1978) who charged that "attempts to use consumer surplus to measure welfare losses are largely the application of the inappropriate to measure the undefinable." Hicks, on the other hand, argued strongly that consumer surplus is useful to welfare economics and his view has come to prevail amongst those who conduct benefit-cost analysis.

Hicks (1941, 1943, 1956) in a series of works beginning with The Revision of Consumer Surplus (1941) and concluding with The General Theory of Demand (1956) redefined the concept in an attempt to overcome the objections to the Marshallian version. He developed four definitions of consumer surplus which become eight when both price increases and decreases are taken into account. These measures are set forth in Table 1.1. The distinction between the surplus or variation measures depends on whether the consumer is allowed in response to price change to adjust his or her purchases to optimize his or her consumption/(variation) or whether the consumer is simply offered fixed quantities of a particular good (surplus), The second set of distinctions depends upon whether the

Table 1.1 TYPES OF CONSUMER SURPLUS MEASURES FOR CONTINGENT VALUATION STUDIES



consumer's reference point is his or her initial level of utility or not. In the compensation type, the individual moves along the indifference curve determined by his or her present utility. In the case of the equivalence type, the individual moves from a point on one indifference curve (his or her initial utility) to a point on another indifference curve, Thus the equivalence measure always represents either a gain or a loss in utility.

Since none of these measures fulfills the need for a single concept to measure welfare loss or gain from various price or quantity changes, analysts have to choose which of them meets the requirements for their particular case. Mishan, for one, in a series of writings (1947, 1960, 1971, 1976a, 1976b) argued that the Hicksian compensation variation measure is the appropriate measure of welfare gain or loss if a potential Pareto improvement is being considered. He further argued that the variation form rather than the surplus form is the correct measure of consumer surplus. Mishan went so far as to drop all discussion of the compensation surplus measure in his later works including his influential book, Cost-Benefit Analysis (1971, 2d ed. 1976a). The choices between surplus and variation, and compensation and equivalence, were much discussed during the 1970's as analysts conducting the WTP surveys tried to determine which consumer surplus measure is most appropriate for the case of non-marketed environmental goods, the property rights for which are ill defined and which are provided to consumers in fixed quantities. The appropriateness of measures involving paying for the good (WTP) versus accepting compensation for it (WTA) was also discussed and tested empirically during this period. We conclude

from our review of these discussions and experiments that the most appropriate measure of consumer surplus for WTP surveys is the compensation-surplus WTP measure and that when methodological considerations preclude the use of questions in this form, the equivalence surplus WTP measure should be used,

Surplus vs. Variation

Let us address the surplus vs. variation choice first. Mishan relegated the surplus form to the dust heap, a position taken implicitly by others, most recently Daniel Feenberg and Edwin S. Mills in their book Measuring the Benefits of Water Pollution Abatement (1980). As we have shown above, however, our case of well defined levels of water quality fits the model of lumpy goods which Randall and Stoll (1980) have shown require the use of Hicksian surplus measures. Since our case is typical of many environmental amenities,the surplus measures are appropriate for most WTP surveys because only they measure people's willingness to pay for fixed quantity/quality bundles of public goods.[8]

The Surplus Measures: Definitions

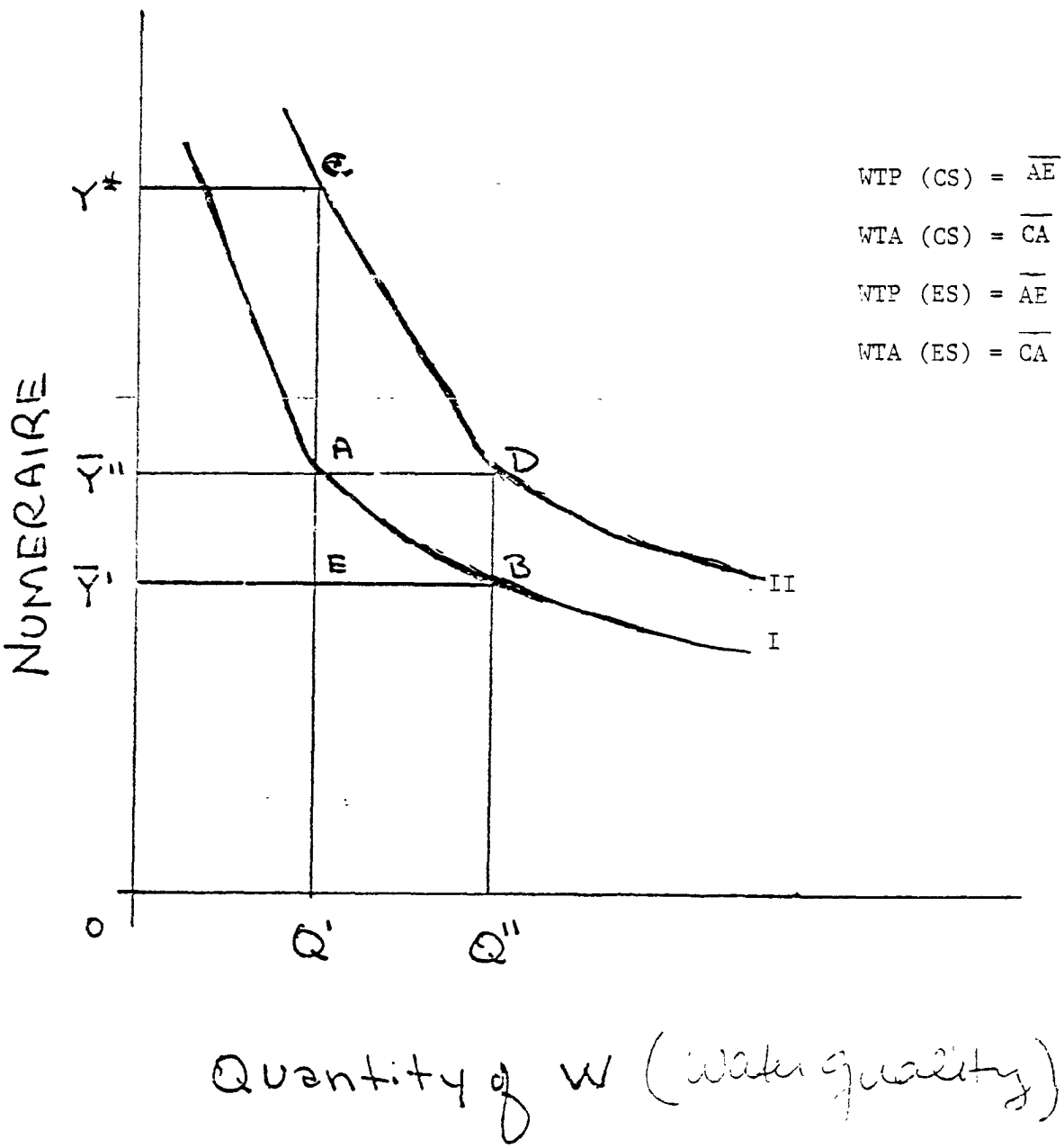
This leaves four measures of consumer surplus as the object of our concern. Before proceeding further let us define these in words and identify them graphically as follows:

[8] Freeman (1979b), after correctly distinguishing the variation and surplus measures according to Hicks' definitions, inexplicably ignores this distinction when he argues that if people are only offered fixed quantities of goods the compensating variation measure is equivalent to the compensating surplus measure and hence one only needs concern himself with the variation measures.

- WTP (CS) --The maximum amount a consumer is willing to pay to obtain a prespecified level of W (e.g. water quality) and have his or her utility remain the same as it was initially,
- WTA (CS) -- The minimum amount a consumer is willing to accept for having W decline to a prespecified level without changing his or her utility.
- WTP (ES) -- The maximum amount a consumer is willing to apy to avoid having W lowered to a prespecified level; either the change in water quality or the payment will lower the consumer's utility.
- WTA (ES) -- The minimum amount a consumer is willing to accept to forego a promised increase to a prespecified higher level of w. Either the payment or a higher level of W will increase the consumer's utility level.

On Figure 1.2, if the initial position is A, and the prespecified improvement is Q' to Q", then WTP^{cs} is the amount of Y represented by the line segment $\overline{AE}$ WTP^{es} is the amount Y represents by the line segment $\overline{AE}$. The reduction in utility is accomplished by moving the consumer from D(Q" on II) to A(Q' on I). The consumer is then indifferent between trading $\overline{AE}$ amount of Y to get back to Q", the original endowment of W. WTA^{cs} is the amount of Y represented by the line segment CA. The consumer in this case is moving along indifference curve II going from Q" to Q' in exchange for AC of Y. WTA^{es} represents an increase in utility, To make this example parallel with the the WTP^{es} measure, the consumer will move from A(Q' on I) to D(Q" on II) and is asked how much Y would it take to move back to his or her original endowment of Q but remain on indifference curve II. That quantity shown on the graph is $\overline{CA}$.

Figure 1.2 HICKSIAN SURPLUS MEASURES



From Figure 1.2 it is readily apparent that the two willingness to pay measures are equal and that the two willingness to accept measures are equal. Further, it is apparent that the WTA measures are not income bounded. Without proof (which may be found in Willig, 1976; Randall and Stoll, 1980; and Brookshire, Randall, and Stoll, 1980) we cite the following useful generalizations about the relationship between the measures: (1) WTP $\leq$ Marshallian Consumer Surplus (M) $\leq$ WTA, (2) for the case of zero income elasticity of income for the public good, all of the Hicksian measures are equal and are also equal to the Marshallian (M) consumer surplus, and (3) when income elasticity (price flexibility of income for the good)[9] is small (generally less than 1) and/or WTP (WTA) is small relative to income (generally 5% or less) the bounds between WTP and WTA have been rigorously defined and are usually less than estimation error. From these findings we may conclude that the two WTP or the two WTA measures may be freely substituted for each other and that these measures will be close to the Marshallian consumer surplus observed from market data and that the WTA measures could be derived from the WTP measure or vice versa. Empirically the bounds between the WTA and WTP measures would be / testable if it were not for respondents' aversion to the WTA measures which we discuss shortly.

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[9] Price flexibility of income for a good is analogous for the income elasticity for a good except that only specified quantities of the good are supplied (Randall and Stoll, 1980).

Table 1.2 TYPES OF PROPERTY RIGHTS FROM THE CONSUMER'S PERSPECTIVE

Implied Property Rights	Legal Property Rights: Yes (Vested by Law)	Legal Property Rights: No (Not Vested by Law)
Yes (consumer holds)	Legal property *Boatable*	"Squatters Rights"
NO (consumer does not hold)	Hypothetical *Fishable* *Swimmable*	Non property

Criteria for Choosing Between the Hicksian Surplus Measures

Now that we have defined the four types of Hicksian surplus measures let us consider them from the standpoint of measuring consumer surplus in WTP/A surveys.[10] They are formed by combinations of two set of distinctions: equivalence vs. compensation and willingness to pay vs. willingness to accept. To determine which combination is the correct measure for an environmental good being valued in a WTP/A survey we need to compare the property rights posited in the questionnaire with the actual distribution of property rights for that good. Before making our argument we need to distinguish two types of property rights. The usual sense of property right is a right vested by law. In much of what follows we speak of property rights in different sense, as the actual endowment of goods held by a person, to which he or she can add or subtract (Silverberg, 1978). Freeman calls this "implied property rights" (1979b). Table 1.2 shows the relationship between these two types of property rights, names the categories, and locates the boatable, fishable, swimmable levels of water quality.

Speaking now of property rights (implied), the initial endowment or implied property right defines the initial indifference curve that the consumer is on. Additions or subtractions of goods to the consumer's initial bundle of good which are counterbalanced (thereby preserving the same utility level) are Hicksian compensation measures. Changes in the initial endowment or implied property right which are not exactly counter balanced (thereby shifting the consumer to another indifference curve) are equivalence measures. From the standpoint of the individual

[10] At this point we will temporarily refer to these surveys as WTP/A in order to avoid terminological confusion.

consumer, if producers have the right to pollute waterways then consumers must bribe them into not polluting if the consumers desire better water quality. This calls for a WTP measure. In the opposite case, where consumers own the right, producers must bribe the consumers if they wish to pollute and a WTA measure should be used. Compensating surplus measures are appropriate when the contingent situation described to respondents in a WTP/A study uses the same distribution of property rights as actually exists at the time of the study. In this case there is no redistribution implied in the instrument and the potential Pareto-improvement becomes the proper criterion. Where the instrument posits a property right which differs from the existing situation, redistribution is implied and the equivalence surplus measure is called for (Mishan, 1976a). Table 1.3 cross-tabulates the existing and the contingent property rights to show which measures of consumer surplus are theoretically correct for the four combinations. While these distinctions are clear theoretically, in practice they are difficult to apply to WTP/A instruments. We will illustrate this difficulty by discussing our choice of consumer surplus measures and why we believe WTP/A surveys are restricted to the equivalence and compensating WTP measures.

We sought to measure the respondent's consumer surplus for three levels of national water quality: boatable, fishable and swimmable. To identify the theoretically appropriate consumer surplus measure we had to decide what property right (implied) consumers presently have for these environmental amenities. The Federal Water Pollution Control Act (as amended)

Table 1.3 ROLE OF PROPERTY RIGHTS IN DETERMINING THE RELATIONSHIP OF THE WTP, WTA, COMPENSATING AND EQUIVALENCE DIMENSIONS OF CONSUMER SURPLUS MEASURES FOR WTP/A SURVEYS VALUING ENVIRONMENTAL PUBLIC GOODS

Contingent Property Right Specified in the Questionnaire (Implied)	*The Existing Property Right (Implied)*	
	Consumers Own	Consumers Do not own
Consumers own	Compensating WTA	Equivalence WTA
Consumers do not own	Equivalence WTP *RFF Q.82*	Compensating WTP *RFF Qs. 83, 84*

endows the public (individual consumers) with a legal entitlement to fishable/swimmable water nationwide, the goal specified in the Act to be achieved by 1983. Its Congressional architects declared: "This legislation would clearly establish that no one has the right to pollute -- that pollution continues because of technological limits, not because of any inherent right to use the nation's waterways for the purposes of disposing of wastes" (Rosenbaum, 1977:159). Feenberg and Hills (1980), however, contend that in practice property rights to water quality are ill defined and in a state of flux. We agree and think this is particularly the case from the consumer's point of view. Many consumers are personally unaware of the national goal. What they hear about is national freshwater lakes and stream virtually all of which are at the boatable level at the present time, although what they experience locally may be of higher quality. In this context and with regard to the overall national level of water quality which is the public good we are valuing, we believe the implied property right is such that it is appropriate to treat freshwater of boatable quality as if the rights to it are actually owned by consumers and to regard rights to water of higher quality as not (yet) owned by them.

When it comes to deciding how to specify the property right (implied) in our questionnaire theoretical purity gave way, as we believe it must, to methodological realism. In theory the distribution of property rights (implied) for water quality, as specified above, should be replicated in the questionnaire. If we did this the consumer surplus associated with

boatable water over some base (very low quality) level would have to be measured by a compensating WTA question and swimmable and fishable water by a compensating WTP question. While we followed this theoretically desirable practice for the swimmable and fishable levels (Qs. 83, 84), for methodological reasons we measured the boatable level (Q. 82) with an equivalence WTP measure instead of a compensating WTA item.

We made this substitution because the hypothetical market presented in WTP/A instruments must accord sufficiently with the respondents frame of reference, otherwise respondents will give meaningless answers. Clearly, asking our respondents how much they are willing to pay for higher (fishable and swimmable) levels of water quality than they presently enjoy (WTP^{CS}) meets the frame of reference test especially as compared with the alternative of asking them to accept compensation for reductions in levels which they have not yet received (WTA^{CS}). The use of WTP^{CS} is not appropriate for boatable water, however, since the respondents already enjoy national water of that quality. It would be inconsistent to have them pretend that national water quality is non-boatable and to ask them how much they are willing to pay to raise it to the boatable level. The theoretically appropriate measure, WTA^{CS}, also fails the frame of reference test. Analysts who have attempted to ask WTA questions report that an unacceptably large number of respondents respond to WTA questions by either refusing to answer the questions or by saying there is no price they would accept for the loss of environmental quality being valued. In one study of the value people place on visibility in the Pour Corners region 52 and 51 percent of

two samples recorded infinity bids for the WTA questions (Eastman, et al., 1974:581) In another study of the value of hunting to hunters, 54 percent refused to accept any finite amount of compensation (Brookshire, et al., 1980:487). The WTA format places respondents in a situation which is both unfamiliar and which is perceived by many as unfair. People are not accustomed to being offered compensation for environmental goods and apparently some feel offended by the notion. These considerations lead researchers who have experimented with the WTA format to conclude: "We cannot recommend compensation (WTA) games" (Eastman, et al., 1974:583) and "iterative bidding formats for the direct observation of WTA^{cs} do not appear to collect reliable value data" (Brookshire, et al., 1980:488).

Fortunately the empirical consequences of yielding to methodological considerations in the choice of the consumer surplus measure are minor. Randall and Stoll (1980) and Brookshire et al. (1980) have calculated rigorous bounds for the difference between WTP and WTA measures. Using their equations the WTA measures can be derived from the WTP measure and the differences between the two are small. For example, using equations (11) $\frac{M - WTP}{M} \simeq \frac{\xi M}{2\bar{Y}}$ and (13) WTA - WTP $\simeq \frac{\xi M^2}{\bar{Y}}$ of Randall and Stoll (1980), and assuming for illustrative purposes the price flexibility of income (ξ) = .7, household income ($\bar{Y}$) = \$18,000 and WTP = \$250, WTA can be derived from WTP. Equation (11) is solvent for M using a quadratic and then substituted into equation 13. The difference between the WTP and the WTA measures is approximately \$2.50 or 1 percent of WTP.

The Nature of Water Benefits

Water pollution has a wide range of effects on various types of consumers and potential consumers. Insofar as these effects are harmful, they impose "costs." Since the expense of reducing pollution involves another type of "cost" we can avoid unnecessary semantic confusion by calling the losses imposed by a reduction of environmental quality "damages," and the gains associated with reduced pollution "benefits" (Freeman, 1979b).

The basis for determining what is to be regarded as a damage or a benefit is individuals' preferences about the ideal state of the world. We tend to assume a societal consensus about which effects of a given change in pollution should be defined as benefits and which as damages, but such a consensus is not inevitable. If, for example, a significant segment of the population harbored an aesthetic preference for misty landscapes they might regard a reduction in air visibility from 100 miles to 40 miles caused by the operation of large scale coal-fired power plants in the Southwest as a benefit rather than as a damage. Fortunately, a strong consensus does seem to exist as to which environmental changes should be considered benefits and which as damages; otherwise benefit estimation would be even more complex than is currently the case. The consensus does not extend to the amount of the benefit created by a change in an environmental good. Since this varies across individuals, "We define the benefit of an environmental improvement as the sum of the monetary values assigned to these effects by all the individuals directly or indirectly affected by that action" (Freeman, 1979b:3).

As the benefits associated with changes in an environmental media such as water are diverse, any attempt to estimate benefits must specify which benefits are to be measured and which are not. Otherwise certain benefits may be inadvertently left out or others may be overestimated due to double counting. There are several lists of the benefits of improved water quality in the literature (Feenberg and Mills, 1980; Freeman, 1979a), none of which is full satisfactory. Table 1.4 offers our categorization of water benefits. It builds on previous distinctions for the most part, but adds a category of non-direct use benefits which we call "indirect" benefits and assembles all the non-direct use benefits in a single "intrinsic" category.

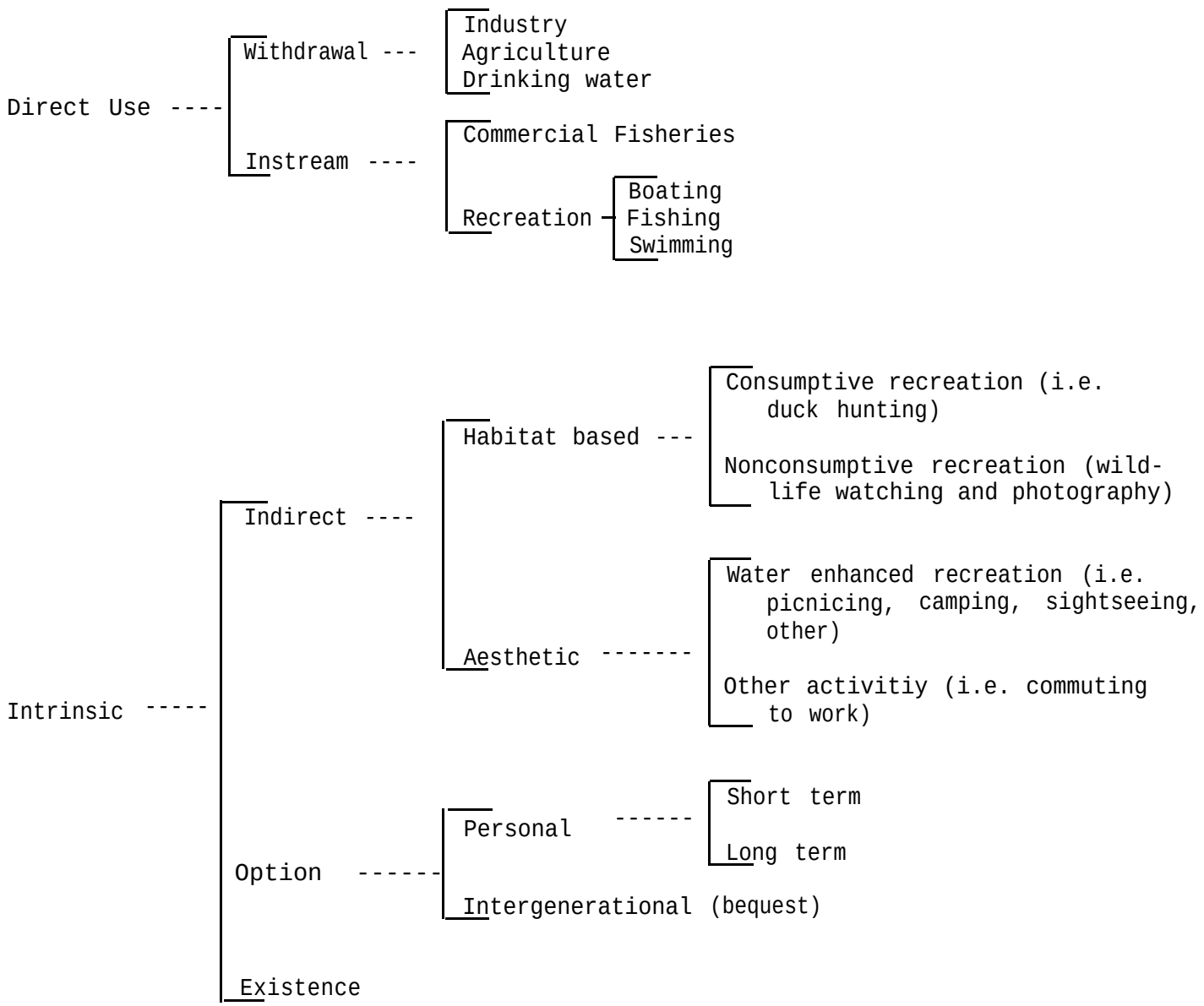
Direct use refers to activities which currently use water either by withdrawal or by instream use (Feenberg and Mills, 1980:8). Improved water quality in freshwater rivers, streams and lakes can result in a variety of withdrawal benefits.[11] Industries which require water of a certain quality for their processes might have lower water purifying costs and less damage to equipment which uses water. Likewise the costs of purifying water for use in washing agricultural produce might be lowered. Drinking water benefits would occur if the improved quality of raw water supply sources lowers the costs of purification and/or reduces the health damage by previously unremoved pollutants. (A companion report to EPA under our cooperative agreement by Mark Sharefkin addresses the question of drinking water benefits.)

Instream use benefits occur in two ways: via increased output or lower costs in commercial fisheries and via the array of activities --

[11] These are comparable to what Freeman (1979a) calls "diversion uses."

NATIONAL BENEFITS OF CLEAN WATER

Table 1.4



fishing, swimming, the like -- by which people use water to recreate. These activities are very popular -- two-thirds of our respondents participated in at of during the past two years -- to estimate national benefits a of the of water pollution control. Freeman (1979a), gives a where recreation accounts of of water recreation use the travel cost "participation model" approach, (1977) used the WTP method to estimate the benefits of achieving swimmable quality water of Massachusetts.

Water its direct use to uses. We category of values intrinsic since they the inherent characteristics of freshwater bodies. are less the direct use benefits and are consequentially less studied. Freeman's of recent water devotes a mere two pages to the handful of studies on this "This is a very which to non-user benefits" (1979a:162). Prior to the no study attempted to measure

the overall intrinsic benefit for water quality and the existence, intergenerational and option values of water quality were measured by only a single regional study using the WTP method. (This study is described in Walsh, et al., 1978 and Greenley, et al., 1980).

We divide intrinsic benefits into three major sub-categories: indirect, option and existence. Indirect benefits occur when water supports or enhances out-of-stream (non water contact) activities. Duck hunters and bird watchers who enjoy observing acquatic species benefit from the availability of marshes and lakes which provide the necessary habitat for these birds.[12] Fresh water is an aesthetically pleasing setting for such diverse recreational experiences as picnicking by a stream, hiking in wilderness areas, strolling through a New England village located on a river, or visiting the gambling casinos at Lake Tahoe. Aesthetic benefits also accrue to people for whom rivers, lakes or streams serve as a backdrop to their normal activities. Although some would list property values here as a distinct indirect benefit category, we believe property values should be regarded as a surrogate measure of aesthetic and recreational benefits. Adding them to the list would result in double counting (Freeman, 1979b).

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[12] In a recent paper, Hay and McConnell (1979) review the sparse literature on the value of non-consumptive wildlife recreation and attempt to estimate the reduced form participation model demand for such activities. For comments on statistical procedures see Vaughan and Russell (1981) and Hayward and McConnell (1981).

Weisbrod (1964) first identified option values as an additional form of benefit that must be added to the consumer surplus measure. The essential nature of option value is contained in Greenley, et al.'s definition (1980) of option value as a willingness to pay for the "opportunity to choose from among competing alternative uses of a natural environment in the future." We distinguish between option value based on whether the individual values the future opportunity to choose for his or her personal use (personal option value) or the use of future generations (intergenerational option value).

Let us consider personal option benefits first. These benefits refer to the value people place on a particular environmental amenity on the chance that they personally may wish to use that amenity at some time in the future. Among the three conditions which Weisbrod asserted must be met for determining the presence of option value is that a decision about supplying the amenity in the future is about to be made and should that decision be negative it would be very difficult or impossible to reestablish it (Cicchetti and Freeman, 1971:528). There are two situations where this condition holds and we distinguish between what we call short term and long term individual option value on the basis of these conditions. The first is where present use or failure to protect an amenity will damage it irreversibly.[12a] If the damage can be reversed in the future (at some expense of course) and the individual does not expect to exercise the option in the "near" future, the individual need not make a present choice between the damaging use and non-use to preserve

[12a] Our use of irreversibility extends to situations where the damage could be undone at a future date but at a much greater expense.

his or her use option. We define long term option value, therefore, as the value people place on a good which is regarded as facing possible irreversible damage.

What about the situation where an individual is uncertain about whether or not he or she may wish to use an amenity in the relatively near future? Under certain conditions such an amenity will have option value for a person even when it is not threatened with irreversible damage. We call this short term option value which we define as the price people will pay to have the option to use a good immediately or, in the case where a period of repair (e.g. pollution control) is required to make the good usable, to use the good as soon as possible. Unless the person wishes to use this (non-irreversibly threatened) good as soon as possible, however, it should have no option for him or her. For example, Lake W. is not now swimmable because of seepage from septic tanks but if a sewage treatment plant were constructed it could be made swimmable in five years, It is not threatened with irreversible pollution. If person X wishes to have the option to swim in the lake as soon as possible (e.g. five years from now), he or she has a short term option value for that amenity. If the person has a longer option time frame, however, it would make no sense for the person to express a WTP option value today since the potential to clean the lake up after a five year effort will continue to exist. Put another way, since the damage can be reversed in the future the individual need not make a present choice between the damaging use (continued use of septic tanks) and a cleanup program to preserve his or

her option to swim in the lake. Instead, he or she should use his or her money for other purposes. Table 1.5 summarizes the conditions under which people will hold long and/or short term option values for environmental goods.

Intergenerational or bequest option benefits comprise the willingness of members of the present generation to pay to endow succeeding generations with some natural environment. Some individuals may place a value on preserving such amenities as streams from being essentially destroyed by strip mining operations simply because they would feel better knowing that these streams would still be available for their children or future generations to use if they want to. A parallel argument is made by some that ecosystems and species should be preserved even when they have no present "use" because the reduction of genetic diversity in this manner reduces the possibilities available to future generations to use such species in the ways we are presently unable to imagine. This perspective has become law in the Endangered Species Act and was instrumental in delaying the construction of the Tellico Dam in Tennessee when it was found that the dam threatened an endangered species of minnow, the snail darter.

Table 1.5 CONDITIONS UNDER WHICH PEOPLE MAY HOLD LONG AND SHORT PERSONAL OPTION VALUES FOR ENVIRONMENTAL GOODS

Desire to have option to use good as soon as possible?	Irreversible Threat? Yes	No
Yes	Long and short term	Short term
No	Long term	No option value

As with the long term personal option value, these benefits rest on the assumption that the action taken by the present generation poses an irreversible threat to the environmental good in question. It is worth noting here that the benefit-cost analysis procedures in current use effectively value benefits or costs a generation or more in the future at zero by imposing real discount rates of about 5 percent (Ben-David, et al., 1979:33).

The only empirical study of the option values of water quality is by a team of economists from Colorado State University who designed a WTP instrument on the basis of Henry's (1974) option value mode. Henry's model posits the "preservation of an irreplaceable environmental asset facing an imminent irreversible commitment, until such time that sufficient information becomes available affecting the future option decision of selecting from among alternative uses" (Greenley, et al., 1980:3). The researchers interviewed a sample of two hundred and two residents of Denver and Port Collins. In order to measure the recreation, option, existence and preservation benefits of different levels of water quality in the South Platte River Basin (Northeast Colorado) the respondents were asked a formidable array of willingness to pay questions (twelve in all) using the bidding game format. The personal (short term) option value question posed two alternatives for the Basin. Alternative I featured a large expansion in mining development which would severely pollute, in an irreversible fashion, "many" lakes and streams. Under Alternative II, any decision to expand mining would be postponed

until information became available, sufficient for the respondent to make a decision "with near certainty as to whether it is more beneficial to you to preserve the waterways at level A (the highest level) for your recreational use or to permit mining development" (Greenley, et al., 1980:13). Using an additional fraction of a percent to the region's sales tax as the payment vehicle,[13] an annual mean bid per household of $22.60 to postpone development was reported for the 177 respondents who answered the question. The study also measured intergenerational option benefits by asking the following question:

> Q.28 If it were certain you would not use the South Platte River Basin for water-based recreation [which they defined as including both direct and indirect recreational use], would you be willing to add __ cents on the dollar to present sales taxes every year to ensure that future generations will be able to enjoy clean water at level A? (Walsh, et al., 1978:82).

A bequest value of $16.97 a year per household is reported for a subsample of 24 non-recreationists.[14]

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[13] They repeated each bidding game using a second bidding vehicle, an additional charge to the respondent's water bill.

[14] The researchers eschew using the intergenerational option benefit amount for the recreators in their sample because they doubt the recreator's ability to leave out their personal recreational considerations when answering this question. Based on our review of the instrument this is the correct decision, but it reduces the sample size so much that the bequest estimate can only be regarded as suggestive (Greenley, et al., 1980:15, 33).

The final type of intrinsic benefit is existence benefits. In 1967 Krutilla wryly commented regarding wilderness that: "There are many persons who obtain satisfaction from mere knowledge that part of wilderness North America remains even though they would be appalled by the prospect of being exposed to it" (1967; see also Krutilla and Fisher, 1975). Existence value is the willingness to pay for the knowledge that a natural environment is preserved (Greenley, et al., 1980:1) quite apart from any use or expectation of use by the respondent or by future generations. The lone attempt to measure the existence benefits of water quality is the above mentioned Colorado State study which uses the following question:

> Q.27 If it were certain you would not use the South Platte River Basin for water-based recreation would you be willing to add __ cents on the dollar to present sales taxes every year, just to know clean water exists at level A as a natural habitat for plants, fish, wildlife, etc?

They report a mean figure of $24.98 for the 24 non-recreationalists who answered this question.

Since the Colorado State study represents the state of the art in estimating option and existence benefits, a closer examination of its methodology is relevant to our purposes. Three questions will be addressed. Is it methodologically sound? How adequate are their measurements and estimation procedures for option and existence values? How much credence should be placed on their annual benefit estimate for the South Platte River Basin of $61 million of which $26.4 million or 43 percent is attributed to recreation benefits (both direct and, using our terminology, aesthetic) leaving 57 percent attributed to option, existence and bequest benefits?

The study is a useful methodological experiment from which we can learn a great deal thanks to the admirably complete report they wrote for their sponsor (Walsh, et al., 1978) and which is available through NTIS. Unfortunately, the study's flaws are such that the researchers' decision to extrapolate their findings without qualifications or reservations in the form of aggregate point estimates in the report and in a brief journal article (Greenley, et al., 1980) is unwarranted and potentially misleading.

Since we are primarily concerned with the study's approach to measuring intrinsic benefits, we will only briefly mention the more serious of its other methodological problems. These are:

- A low response rate -- only 37 percent of the sampled households which received the letter announcing the intention of the researchers to interview a household member participated. According to sampling theory this low a rate means that the findings cannot be generalized to the total population of those areas which constitute the study's sampling frame.
- Starting point bias. The large difference in results between their two bidding vehicles -- sales tax increase and increase in sewer

bills -- may be attributed to the aggregate yearly payment implied by the starting point for each vehicle.[15] Furthermore, the mean bids for option, bequest, and existence values are very close to the starting point for each vehicle.[16] Since their questionnaire involved so many bidding games, a combination of respondent fatigue and a willingness to please the interviewer possibly may account for a large portion of the bids.

- The payment vehicle, additional taxes at the regional level, is ambiguous. Since water quality actually is paid for in higher prices and federal income taxes for the most part, the respondents are already paying large amounts for this purpose. We have no way of knowing whether the respondents are

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[15] The starting points for the vehicles were one quarter of a cent increment in sales tax and $.50 a month on the water sewer bill. Prior to bidding the respondents were informed how much additional money they would pay a year for every one quarter cent increment in sales tax. (Walsh, et al., 1979:29). The study report does not say whether an annual amount for the water/sewer fee was calculated for the respondents but even if it wasn't the respondents would be able to calculate this easily themselves. For the entire sample they report an annual recreation value of $18.60 for the water fee vehicle and $56.68 for the sales tax. (Every respondent bid for recreation using each of the vehicles, total N = 174) The only explanation they offer for respondents' willingness to pay only about one-fourth as much in water-sewer fees as in sales tax was that they "may have perceived inequities" in the fees since everyone, including tourists, would be liable for sales taxes (Greenley, et al., 1980:17). However, since the starting points for the two vehicles "generated revenue of $6 per year in water-sewer fees and $25 per year in sales tax for a typical household of four with an average income of $13,500 per year" (Greenley, et al., 1980:11), it is more likely that the difference results from starting point bias.

[16] In Table 1 of Greenley, et al. (1980) they give the mean bid for option, bequest and existence values for each vehicle. In every case, irrespective of vehicle, the bids for these values hover around the starting point. The average difference from the starting point is 17 percent. (It is true, however, that the bequest value lies slightly below the starting point, while the other two have mean bids above the starting point, suggesting that people do value bequest values less than the other two.)

willing to pay these amounts plus the additional amounts elicited in the bidding games or not.

Of direct importance to our present discussion is the method used by the Colorado State researchers to measure the option and existence values. Their approach is additive. They ask separate questions for each of the four benefit categories (recreation, option, bequest and existence) and add the resulting mean bids to get a total WTP figure for the Basin's water quality. Since the additive technique requires each benefit to be measured independently with no overlap, the WTP instrument must ensure that respondents bid on one value at a time and only on that value. Otherwise double counting will occur biasing the total estimate upward and making it impossible to derive reliable estimates for the component values. A close scrutiny of the wording of the recreational and option value questions in the Colorado State instrument raises serious doubts about their independence.[17]

Here is the wording of the question they used to measure recreational value:

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[17] In the case of the existence and bequest values, however, they recognized after the fact that their survey "did not ask users about (these benefits) in such a way as to permit adding them to user's values" (Walsh, et al., 1978:39). For this reason they restricted their estimates of these benefits to the very small number of non-recreationists. In the discussion which follows we consider only the recreation and option values, both of which they estimated for the full sample, although we believe our criticism also holds for the other two measures.

Suppose a sales tax was collected from the citizens of the South Platte River Basin for the purpose of financing water quality in this Basin. All of the additional tax would be used for water quality improvements to enhance recreational enjoyment. Every Basin resident would pay the tax. All bodies of water in the River Basin would be cleaned up by 1983. Assume that this is the only way to finance water quality improvement.

14. Would you be willing to add ____ cents on the dollar to present sales taxes every year, if that resulted in an improvement from situation C to situation B?

15. Would you be willing to add ____ cents on the dollar to present sales taxes every year, if that resulted in an improvement from situation C to situation A?

The three water quality levels A (best), B (medium) and C (worst) were represented by photographs showing colored water features associated with mine drainage. Although the wording says all the additional tax would be used "to enhance recreational enjoyment" the question does not explicitly ask the respondent to limit his or her answer to recreational benefits nor does it inform the respondent that he or she will be presented with subsequent opportunities to say how much they are willing to pay for other (intrinsic) values. Since the apportioning of water quality values to precise categories is not a familiar undertaking for most people, the form of the question with its emphasis upon the quality shift from C to B and C to A and the use of the pictures which depict aesthetic degradation serve to create the impression that the respondent is being asked about water pollution in general. The bids for the recreation question probably should be regarded as the consumer's total willingness to pay for an increase in water quality in the area from C to A.

The option value question has the same weakness. Although the researchers are careful to specify the option characteristics in accord with their theoretical model, the question is worded in such a way that the respondents could interpret it as asking them to value water quality of level A while bearing in mind the economic tradeoff of foregoing mining activity. (A Further problem with the option question is that the respondents may not believe level C to be irreversible since the recreational questions in the interview told them that level C could be improved to levels B or A.) The option question is worded as follows:

> In the near future, one of two alternatives is likely to occur in the South Platte River Basin. The first alternative is that a large expansion in mining development will soon take place, creating jobs and income for the region. As a consequence, however, many lakes and streams would become severely polluted. It is highly unlikely, as is shown in situation C, that these waterways could ever be returned to their natural condition. They could not be used for recreation. Growing demand could cause all other waterways in the area to be crowded with other recreationists.
>
> The second possible alternative is to postpone any decision to expand mining activities which would irreversibly pollute these waterways. During this time, they would be preserved at level A for your recreational use. Furthermore, information would become available enabling you to preserve the waterways at level A for your recreational use or to permit mining development. Of course, if the first alternative takes place, you could not make this future choice since the waterways would be irreversibly polluted.
>
> 26. Given your chances of future recreational use, would you be willing to add ____ cents on the dollar to present sales taxes every year to postpone mining development? This postponement

> would permit information to become available enabling you to make a decision with near certainty in the future as to which option (recreational use or mining development) would be most beneficial to you?

Whereas the "recreational value" questions (14 and 15) ask the respondents to imagine that they are at level C or B and to say how much they are willing to pay to move to level A, the "option value" question asks them to assume that they are at level A and asks how much they are willing to pay to remain at level A instead of moving to level C. In this respect, the question is simply another way of measuring the consumer surplus for level A and we would again anticipate that the respondents' WTP amounts will reflect their total recreational and intrinsic values for water quality rather than just the intended independent (and additive) option value. Of course the bids on this question will be influenced by the additional information conveyed by Question 26, namely: a) the water quality change will be irreversible; b) keeping water quality at level A involves economic tradeoffs (jobs and income) and c) there is pressure for such development. This last point, which is implied rather than stated, might lead the respondent to believe that further mining activity is inevitable,[18] and therefore to give low or zero bids.

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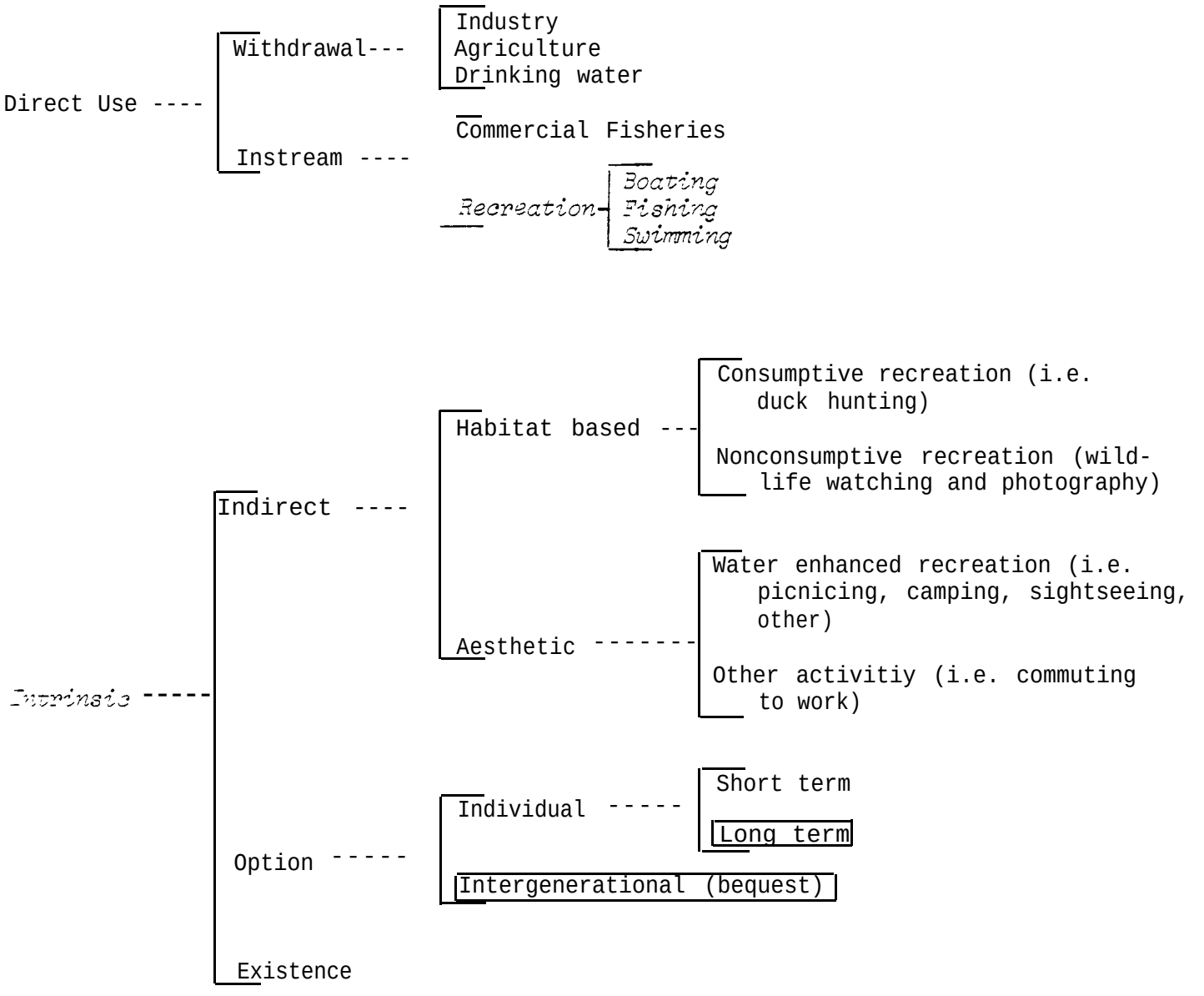
[18] These factors may explain why the "option" question received a lower mean bid ($23) than the "recreation" question ($57).

In this study we use an approach which contrasts with the Colorado State method in several respects. First, we do not attempt to measure the various sub-categories of intrinsic benefits as they did, although we do obtain separate estimates for the overall intrinsic benefits and for the in-stream recreational benefits. Second, we begin by ascertaining the individuals' total consumer benefits (recreational plus intrinsic) through a sequence of WTP questions. Only then do we apportion these total benefits to the separate recreational and intrinsic categories as the basis of information which we obtained in the interview about the respondents' recreational use or non-use of freshwater. Our process is subtractive rather than additive and uses self-reported behavior rather than answers to specific WTP questions to distinguish recreational from intrinsic benefits. Working backwards from a total benefit figure has the advantage of forcing respondents to consider their budget restraints more realisitically than in the case when they are asked to value a sequence of component benefits without confronting the overall expenditure involved in these separate decisions. Table 1.6 shows which of the benefit categories in Table 1.4 we measure in this study. We present our findings in Chapter 5.

Table 1.6 NATIONAL BENEFITS OF CLEAN WATER MEASURED BY THE RFF SURVEY



Categories in italics are those estimated in this report. The subcategories in the boxes are not included in our intrinsic benefits total because the changes in water quality which we value are defined as irreversible.

CHAPTER 2
THE MACRO APPROACH TO WILLINGNESS TO PAY STUDIES

Our review of studies using the willingness to pay method reveals two distinct research traditions. In one tradition, willingness-to-pay questions are used in national polls as a measure of environmental concern. In the other, the questions are employed by economists to develop benefit estimates for particular environmental goods. We have named these approaches the macro and micro, respectively. Each has advantages and disadvantages for benefit estimation. We have experimented with a new kind of macro approach, one which borrows heavily from methodological innovations developed by practitioners of the micro approach. In this chapter we describe these two approaches and the rationale behind our synthesis.

The Macro Willingness to Pay Approach

Since 1969 at least 8 different surveys have asked questions using the "macro willingness to pay" (macro WTP type). The kind of environmental public goods covered in these surveys range from air pollution devices on new automobiles Viladus, 1973) to the more general category of "cleaning up pollution now" (Gallup, 1971). They also vary in how they ask for the amount. Some questions are open ended, but macro WTP questions usually offer a specific amount or a limited sequence of specific amounts for the respondent's judgment. For example, in 1969 a Harris poll for the National Wildlife Federation asked 1500 adults nationwide:

> You are already sharing in the costs brought to us all by air and water pollution. In order to solve our national problems of air and water pollution the public may have to pay higher taxes and higher prices for some products. To get real clean-up in your natural environment, would you be willing to accept a per-year increase in your family's total expenses of $200?

The question was repeated for the amounts of $100, $50 and $20. Other examples of macro questions include these taken from national surveys.

> Would you be willing to pay an additional $20 per year on your electric bill in order to cut down air pollution caused by power plants? (Federal Energy Administration, 1977; August 1975 survey).
>
> (After asking people the amount of their last electric bill ....) Now suppose that the only way to stop the electric power plants from polluting is to install expensive equipment, and this equipment made your electric bill go up unless you used less electricity than you use now. How much more would you be willing to pay a month to clean up this form of pollution? $_____ (Viladus, May 1973 survey).

The past uses of the macro WTP approach have the following characteristics:

1. Purpose: In these earlier uses, macro WTP questions were not intended to provide the basis for benefit estimates in the strict sense. They were used for the conventional poll takers purpose of measuring public concern about environmental goods. It is assumed that asking people the amount of money they are personally willing to pay for pollution reduction is a more stringent test of people's concern than questions which simply elicit concern without reference to the cost. The relevant audience for these studies are those who normally use public polls on environmental issues.

2. Survey Method: The macro WTP questions were used in social surveys conducted by professional polling organizations. Because the respondents were chosen by modern sampling techniques, with sample sizes ranging from 800 to 1500, the results may be generalized to the appropriate sampling frame within a statistically determinable degree of accuracy. The interviewers are trained adult workers under contract to the polling

organization whose work is subjected to independent checks. In each use of the macro WTP questions they have been just one component of a larger list of questions.

3. Specification of the good and procedure for ascertaining WTP: The nature and geographical distribution of the environmental good is described in general terms. People are asked about "cutting down air pollution," for example, with no mention of where this would happen or how much "cutting down" is involved. No attempt is made to vary the amount of the good, to provide visual aids describing it, to present the parameters of a hypothetical market in the good, or to sepcify the geographical location which would receive the environmental benefit.

4. Test for biases: The standard assumptions about the reliability/ validity of survey research are applied to the macro WTP questions. These assume that a question is reliable if it uses words which are understood by all the respondents, is unambiguous in meaning, is neutral in its wording, and asks about a matter on which respondents may be presumed to have an opinion. Validity is established by judgment of whether or not the description of the environmental good in the question appears to be adequate (face validity). No attempts were made to undertake specific tests for threats to reliability and validity. Data reporting was limited to presentation of the marginal results and cross tabulation by standard background variables.

5. Sampling Frame: The sampling frame for these surveys was a large geographic area. Most were national (the lower 48 states) although macro WTP questions have occasionally been used in state surveys.

We use "macro" as a label for this tradition of WTP questioning because of its focus on national benefits.[1] No matter what environmental good these questions solicit willingness-to-pay amounts for, the money would pay for supply of the good across the country. The micro approach, as we will see, is interested in the benefits for a specific geographic area.[1a]

The Micro Willingness to Pay Approach

Since the Second World War, economists have been increasingly faced with the need to measure the use values associated with natural resources. Insofar as values associated with goods are measured in the market place in terms of price, obtaining dollar estimates for them is relatively straightforward. But natural resources, including the amenities of clean air and water, have characteristics which severely limit the use of exchange to determine their value for society. Because they have the attributes of public goods especially in that it is difficult or impossible to exclude consumers from using them, they are outside conventional market structures. The rather intangible nature of some of the values these resources convey, such as aesthetic and existence values, means that people are likely to have difficulty imagining the good with precision and conceiving of a hypothetical market in those values.

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[1] If the Grand Canyon has symbolic national value then the location of the benefits is national rather than local.

[1a] Macro need not refer to only national benefits. For instance, the benefit could be global (CO_2, d'Arge et al., 1980) or regional as in a survey of WTP for air quality regulations in California of a random sample of all California (if California only generated and was affected by the air pollution). At the margin the distinction between macro and micro become blurred.

Economists have experimented with ways to overcome these obstacles in order to simulate a market in environmental goods. Among the myriad of techniques developed over the past three decades for this purpose (see Wyckoff, 1971; for an overview as of 1970) is the use of survey research instruments to ask people what they are willing to pay for such goods. Although Ciriacy-Wantrup suggested such a technique -- which he called the "direct interview method" -- as early as 1947 (Wyckoff, 1971:13), it apparently did not come into actual use until the 1960s when Davis (1963) used questionnaires to estimate recreation benefits. Since that time the technique has been used repeatedly by economists to measure such things as recreational benefits (Binkley and Hanemann, 1978; Darling, 1973, McKinney and MacRae, 1978); water quality benefits (Gramlich, 1977; Walsh, et al., 1978) (Davis, 1980); benefits of decreased risk from a nuclear power plant accident (Mulligan, 1978); aesthetic benefits from foregoing a geothermal power plant (Thayer, forthcoming); aesthetic benefits of air visibility (Randall, et al., 1974; Brookshire, et al., 1976; Rowe, et al., 1979a and b); and aesthetic and health benefits of air quality (Brookshire, et al., 1979)

In the course of this research the direct interview technique has been refined and a great deal of study has been given to its possible biases. Much of this work has been undertaken by Randall and colleagues (Randall, et al., 1974) and by d'Arge, Brookshire, Rowe and others from the University of Wyoming in their series of studies on the aesthetic benefits of air pollution reduction. In 1979 the latter group produced a major methodological study of the technique for EPA (Brookshire, et al., 1979).

Figure 2.1 gives the text of a micro WTP question. It was used for a 1975 study of the aesthetic damages of a possible power plant near Lake Powell in Utah and illustrates the essentials of the micro approach. This approach, particularly as used in the air pollution benefits studies, differs from the micro approach in a number of important respects.

1. Purpose: The micro studies are specifically designed to obtain estimates of economic benefits by gathering data which enable the fitting of a demand curve for the value in question. Their designers seek to gather data which will be accepted as valid for this purpose by their fellow economists.

2. Survey Method: The field work for the micro WTP studies is usually conducted by the researchers using student interviewers who are specially trained for the study. The WTP questions are the centerpiece of the survey instrument which is dedicated solely to the benefits measure study. In a number of the past studies sample sizes have been very small by conventional survey research standards; sub-groups which are the focus of extensive analysis sometimes consist of only 20-30 cases. Sometimes the descriptions of the sample frame and procedures are sketchy or lacking entirely[2] in the report so it is difficult to know whether the findings can be generalized reliably to larger populations and what those populations might be. In other case (e.g. Rowe, et al., 1979b:85-89) a representative rather than random sample was used which precludes such generalization.

[2]For example, the interview dates, the response rate, and/or the method of selecting the respondents may be missing.

QUESTIONNAIRE

Bidding Game for Estimation of Recreationists' Demand
for Abatement of Aesthetic Environmental Damage

Good Morning/Afternoon. My name is _____. I'm doing research for the Economics Department at the University of New Mexico, as a part of the Lake Powell Research Project, funded by the John Muir Institute for Environmental Studies.

This research is designed to more closely examine some of the trade-offs between industrial development, recreation and the environment in the Lake Powell area. In connection with these objectives. I would like to ask you a few questions to see how you feel about environmental quality and its future In this area.

1. How many members of your family are here with you? _____persons.

2. What is the expected length of your stay? _____days.

3. Where are you staying? _____(a) local resident. _____(d) developed or semi-developed campground
_____(b) lodge, Page motel
_____(e) remote (specify location)
_____(c) passerby

4. If you don't mind, could you please indicate which of the following brackets your family income falls into:

_____ 0 - 4,999	_____ 20,000 - 26,999
_____ 5,000 - 9,999	_____ 25,000 - 39,999
_____ 10,000 - 14,999	_____ 30,000 - 49,399
_____ 13,000 - 19,999	_____ 50,000 and up

There are plans to construct a large electric generating plant north of Lake Powell. This plant is expected to be at least as large as the Navajo Plant on the south side of the lake.

5. Have you noticed the Navajo Plant or its smokestacks? _____yes _____no

Depending on exactly where and how a new plant is constructed, it could have a significant effect on the quality of the environment. If the plane is built near the lake, it could be visible for many miles up and down the lake. If air pollution is not strictly controlled, visibility in the area may be significantly affected.

These photographs (show) are designed to show how a new powerplant on the north side of the lake might appear. Situation A shows a possible plant site but assumes that the powerplant would be built at some distant location, not visible from the lake area. In Situation B the powerplant is easily seen from the lake, but emits very little smoke; visibility is virtually unaffected. Situation C is intended to show the situation with the greatest impact on the environment of recreationists in the area. It is easily seen from the lake, and the smoke substantially reduces visibility.

Vacationers, of course, spend considerable amounts of money and time and effort to equip themselves with vehicles, boats, camping and fishing gear, and for traveling to the destination of their choice. It is reasonable to assume that the amount of money you are willing to spend for a recreational experience depends, among other things, on the quality of the experience you expect. An improved experience would be expected to be of greater value to you than a degraded one. Since it does cost, money to improve the environment, we would like to get an estimate of how much a better environment is worth to you.

First, let's assume that visitors to GCNRA are to finance environmental improvements by paying an entrance fee to be admitted into the recreation area. This will be the only way to finance such improvements in the area. Let's also assume that all visitors to the area will pay the same daily fee as you, and all the money collected will be used to finance the environmental improvements shown in the photos.

6. Would you be willing to pay a $1.00 per day family fee to prevent Situation C from occurring, thus preserving Situation A? $2.00 per day? (increment by $1.00 per day until a negative response is obtained, then decrease the bid by 25¢ per day until a positive response is obtained, and record the amount.)

7. Would you be willing to pay a $1.00 per day fee to prevent Situation B from occurring, thus preserving Situation A? (Repeat bidding procedure).

8. (Answer only if a zero bid was recorded for question 6 or 7 above.) Did you bid zero because you believe that:

_____ the damage is not significant

_____ it is unfair or immoral to expect the victim of the damage to have to pay the costs of preventing the damage

_____ Other (specify) _____

9. In your opinion, has visibility, depth or color perception in this area been significantly reduced by air pollution?

3. Specifications of the good and procedures for ascertaining WTP: Because of the importance of making the situation as realistic and credible as possible, great attention is given to the description of the environmental good in the micro studies. It is typically described as occurring in a specific locality (usually the locality where the interviewing is taking place); a time frame is specified; and an extensive verbal description of the good is supplemented with pictures or other visual devices. A great deal of care is also given to the procedures for eliciting the WTP amount. The survey instrument describes a hypothetical market with a substantial degree of institutional detail; specific, plausible means of payment are specified; and contingencies relevant to the respondent's valuing the good are described. A common feature of most of these studies is the use of a "bidding game" procedure to ascertain the dollar amount the respondent is willing to pay.

The bidding game works in the following manner: after the hypothetical market is staged by means of preliminary questions, verbal description, and the use of the visual aids, a particular good is identified and the person is asked whether he or she is willing to pay $x for the good. If the starting amount (e.g. one dollar) is agreed to, the interviewer increases it by a set interval (e.g. 50 cents) until the respondent rejects an amount. The study may then require the interviewer to decrease the amount rejected by a smaller amount (e.g. $.25) until the precise maximum amount the individual is willing to pay is reached.[3] This procedure is usually repeated for several levels of the good in question so that the demand curve can be traced out.

4. Test for biases: Because they are explicitly intended to provide benefits estimates for policy purposes, micro studies attempt to obtain as close a surrogate as possible to actual market behavior.

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[3] Several micro studies also used parallel procedures to ascertain how much respondents were willing to accept (WTA) in return for the loss of the environmental good.

> The efficacy of bidding games used for this purpose [to measure aesthetic environmental improvements] depends on the reliability with which stated hypothetical behavior is converted to action, should the hypothetical situation posited in the game arise in actuality (Randall, et al., 1974:135).

Since many economists are skeptical about the fit between attitudes and behavior, credibility in this regard is crucial. Accordingly, those conducting micro studies have placed a great deal of emphasis upon testing for potential biases. In a number of cases, most notably the studies done by d'Arge, Brookshire, and their colleagues, tests for biases are built into the study design as when comparable samples are offered different dollar amounts as starting points for the same environmental good in order to test for starting point bias. Strategic bias has been examined in a similar manner.

5. Sampling frame: The environmental amenities valued by the micro WTP approach are, as we have seen, location specific. Those interviewed for these studies are generally sampled from people who live or recreate in the particular area. This conjunction of a local good and a local sample is intended to reduce the artificiality inherent in the bidding games since people will be bidding on a good which they can easily comprehend and which is of immediate concern to them. For the South Platte River Basin (Colorado) 202 residents of Denver and Fort Collins were interviewed (Walsh, et al., 1978); for the Glen Canyon Recreation Area the 82 respondents included local residents, motel visitors, developed campgrounds visitors and remote campers (Brookshire, et al., 1976).

Comparison

This brief description of these two ongoing research traditions captures the essential features of each as they existed in 1979 when planning for the RFF experiment began. Each has a major strength and a compensating weakness.

Realism

Of the two approaches, the micro approach has been far superior in its realism. People are asked about a good which they personally have experienced or which they would experience in that location if pollution levels increased. The several values associated with the good (existence, aesthetic, health, etc.) are differentiated and the value chosen for measurement is described in detail both verbally and, if possible, pictorially. The payment vehicle and the hypothetical market are designed to match the respondent's experience as closely as possible. In comparison, the designers of the macro questions have made very little effort to stimulate a market or to describe the environmental goods in detail.

Generalizability

Realism is an important factor in designing reliable and valid measures of WTP. But once reliable and valid benefit estimates have been obtained from a set of respondents, for our purposes it is necessary to aggregate them to obtain overall benefits estimates. The great strength of the macro approach with its use of a national sampling frame is the ease with which the results can be generalized to give a national benefits estimate. In contrast, it is difficult to aggregate micro study findings beyond the location where the study was conducted and it is extremely difficult to make reliable national estimates from a series of micro studies.

Probability Sampling and Aggregation

Survey research has a standard solution to the aggregation problem -- probability sampling. If Gallup wants to predict the national presidential vote, he interviews 1500 people nationwide who are chosen by an elaborate sampling procedure based on statistical principles. Providing his survey takes place immediately before the vote and that his interviewers adhere to the sampling plan, he will be able to predict the vote with an accuracy of $\pm$ 3 percent. Good sampling requires: 1) designation of the appropriate sampling frame for the population to which one wishes to generalize (in the Gallup example this is people living in non-institutionalized settings in the lower 48 states), 2) design of a sampling plan which will give every relevant person (e.g. adult voters) a known probability of inclusion, and 3) strict execution of the sample., Once the sampling frame is chosen, the design and execution of the sample is straightforward, although certain adaptations can be made to a strict probability design in the interests of economy without undue bias resulting (see Sudman, 1976, for a review of these procedures).

The choice of the sampling frame necessarily depends upon the researcher's problem and purpose. For WTP studies, it should be the population for which the researcher wishes to have an aggregrate benefit.[4] There are two separate issues involved which complicate the choice of a sampling frame for WTP studies: a) which groups can be presumed to "have" benefits that should be included in any comprehensive measure and b) what groups are relevant under different equity positions; i.e., do only those who pay get to have their benefits counted? Let us suppose that he or she wishes to

[4] The researcher also needs to define any special sub-populations which are likely to have an especially high value for the good in question, If there are such sub-populations, he or she may need to oversample these people. Otherwise they may be too few in number to enable a reliable estimate to be made of their benefits. For example, one in fifteen men in an area may be fishermen. If 300 people are sampled for a study of water recreation benefits in an area only 20 are likely be to fishermen (0.066 x 150) When benefits are aggregated across the entire sample, the benefits for over-sampled sub-population(s) must be weighted to reflect their proportion of

estimate noise pollution control benefits. In the case of a village which wishes to use WTP techniques to estimate the benefits of ordering quieter garbage trucks,which would be paid for out of village property taxes, the appropriate sampling frame is the residents of the village. If noise regulations are a state matter and their cost is paid for by state taxes, then the state population would be the appropriate frame. In both these cases the selection of the sampling frame is simplified because the same population is affected by and pays for the public good in question.

Choosing the appropriate sampling frame becomes more complex where the two do not coincide. The table below shows the four possible relationships between paying for and using a public good. Using our example of the town contemplating the purchase of garbage trucks, an example of B is visitors

		Pay for the Good: yes	Pay for the Good: no
Use the good	yes	A	B
	no	D	C

to the town who would benefit from quiet garbage trucks although they wouldn't pay for them since they are not subject to town property taxes. Position D would include deaf residents and absentee property owners. Note that by using the sampling frame of the town residents, we include some D's (town population = A + D minus absentee taxpayers). Sampling frames comprised of those who live in political jurisdictions responsible for public goods almost

inevitably include both users and non-users. For example, those who reside in a city with a public school system include the childless, people whose children are too young or old for public school, and those who send their children to private schools. Note also that the use of the town population as the sampling frame leaves out some D's. Presuming that property taxes are the source of the town's revenue, absentee landlords would not be represented in a sample of town residents. A different sampling frame consisting of property tax payers would, of course, include them but it would exclude renters[5]

B is an important category for some benefits estimates. Consider the case of the huge Four Corners power plant at Fruitland, New Mexico in the Southwest (Randall, et al., 1974). Residents of the area and visitors who come to enjoy the scenery use the public good of high air visibility without paying the cost of maintaining it. This cost is (would be) borne by those in Los Angeles (and elsewhere) who purchase their electricity from the utility which owns the plant. Nevertheless, area residents and visitors are a crucial sampling frame for a WTP study of the aesthetic benefits of local air visibility.

A further complication is introduced when we consider the question of intrinsic benefits. It may be worth something to Los Angeles residents (D) who never recreate or intend to recreate in the Four Corners area to know that the extraordinary air visibility in that area is untouched by the emissions of the plants which provide their electricity. Indeed, and here we come to position C, it may be worth something to residents of Ohio as well. A local or even regional sampling frame is inadequate if the researcher wishes to include intrinsic benefits in a national estimate of the benefits of high visibility in the Southwest.

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[5] Recognizing, of course, that renters eventually pay all or some of the taxes imposed on landlords.

Interrelationship Between Generalizability and Realism

The sampling frame and the realism of the WTP instrument are interrelated. Where users and payers are in the same population (position A), both the description of the good and the payment vehicle can be related to their actual experience and realism is enhanced. People in position B, may be more unrealistic in their WTP estimates than those in A or D because they know they are not paying for the good and are unlikely to think they will have to pay for it in the future. The good may be especially abstract and hard to imagine for those in position D who pay for the good but who do not use it. Thus the potential for measurement bias is reduced when the sampling frame consists primariy of A's. To the extent that respondents anticipate that their answers will affect their level of payment or their level of supply of the public good, B's estimates will tend to overestimate the consumer surplus and D's to underestimate it owing to the effect of strategic bias.

This description of the strengths and weaknesses of the two research traditions as they have been practiced to date is summarized in the following four-fold table.

Generalizability

Realism		High	Low
	High		micro
	Low	macro	

The obvious goal for a study of public good benefits is to move to the box where the data are both realistic and generalizable. This is a difficult task because the two dimensions are somewhat incompatible, necessitating

tradeoffs between degree of realism and degree of generalizability. Thanks to the experimental micro studies of the 1970s, however, we have a much greater knowledge of the properties of willingness to pay measures. For example, micro research has shown us that certain potential problems such as strategic bias are not as much of a problem as some had thought (see Chapter 4). Knowledge such as this gives the researcher greater flexibility in designing a WTP research instrument, flexibility which was essential to our effort to devise a macro instrument which was workable yet sufficiently realistic in its description of water quality to give US valid results. In Chapter 4 we argue the need to jointly minimize the potential for strategic and hypothetical bias.

The RFF Macro Approach

For public goods which are mandated at the national level and are paid for by everyone in higher prices and taxes there is a need to obtain national benefits estimates. The quality of water in the nation's fresh-water bodies is such a public good. In 1972 Congress passed the Federal Water Pollution Control Act Amendments (later amended). In this law:

> Congress has declared its intent "that the discharge of pollutants into the navigable waters be eliminated by 1985" and that "wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by 1 July 1983." In effect, this amounts to a commitment to make all the nation's navigable waters "swimmable and fishable" by 1983 and wholly free of pollutants in 1985. (Rosenbaum, 1977:158).

The law established a national permit system for all municipal and industrial effluent discharges according to national standards and mandated the use of "best practicable" technology to control water pollution by 1977 and the "best available" technology by 1983. Although it is implemented by the states, the standards and compliance deadlines are set by Washington.

The cost of this mammoth pollution control program is ultimately borne by all U.S. taxpayers and consumers. The federal government provides the construction monies for municipal waste treatment facilities in what is the largest single public works project ever authorized by Congress. Municipal taxes pay to maintain and operate the waste facilities. The expanse of controlling the non-municipal effluents are borne by industry (and ultimately the consumer) and other operators. The reach of the law extends beyond effluent pipes to the many "non-point" sources of water pollution such as fertilizer runoff from farmers' fields.

After a careful consideration of the alternatives, we decided to adopt a macro approach in our study of the intrinsic benefits of water pollution control. A primary impetus for this decision was the national character of control programs. In addition we were influenced by the following considerations

1. The results of the various micro experiments suggested some of the biases involved in the use of surveys would be manageable at the macro level.

Factors mitigating against a micro design:

2. The fact that unlike air pollution, water pollution does not lend itself to the efficient use of site-specific visual aids. This is because: a) perception of water quality is mediated strongly by individual settings; b) the diverse visual values of water include everything from clarity to surface debris; and c) not all visual degradation is due to pollution, making it difficult to distinguish between natural and the human-produced.

3. The diversity of local water bodies in many parts of the country. Lakes, streams and rivers each have different characteristics and even within a particular geographical location they may take many different forms. This diversity poses great problems for micro studies which seek to do more than measure the water quality benefits for a single body of water. Air, in contrast, is a far more homogeneous medium.

Factors favoring a macro design:

4. Both the use of fresh water (for recreation, aesthetic pleasure, etc.) and the payment for the cost of improving its quality occur at the national level. Of course, individual use takes place at the local level, but such use occurs all over the country. Moreover, some people use water in areas far distant from their homes. As noted above, every person pays the cost of improved water quality through a combination of taxes and higher prices and the cost is imposed as a result of national decisions by Congress and EPA.

5. The terms used in the national law mandating the water cleanup to describe the several levels of water quality -- "fishable," "swimmable" -- are readily understood by individual citizens and do not require location specific visual aids.

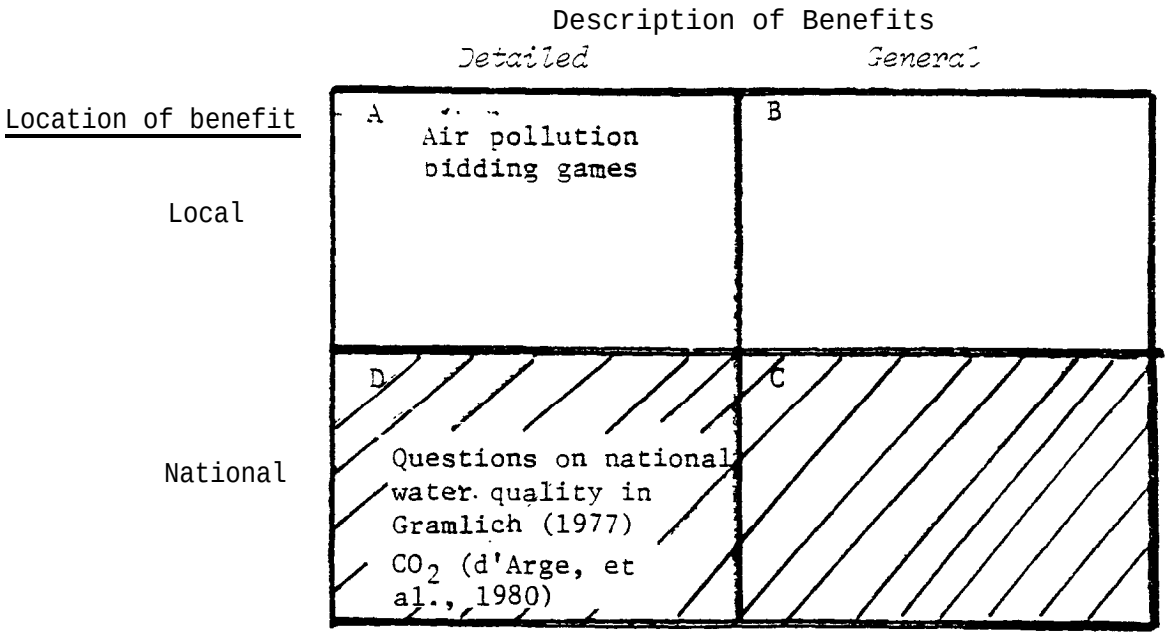
6. That a national survey is particularly suited, for reasons described earlier, for the measurement of the intrinsic value of improved water quality for our special task.

Figure 2 summarizes the major aspects of WTP benefits study design and locates the RFF approach in relation to the other types of approaches which have been used in the past. In contrast to the earlier macro studies, the description of water quality in our instrument is detailed. In contrast to the air pollution bidding games, we use a national sample and measure the benefit for the nation as a whole.

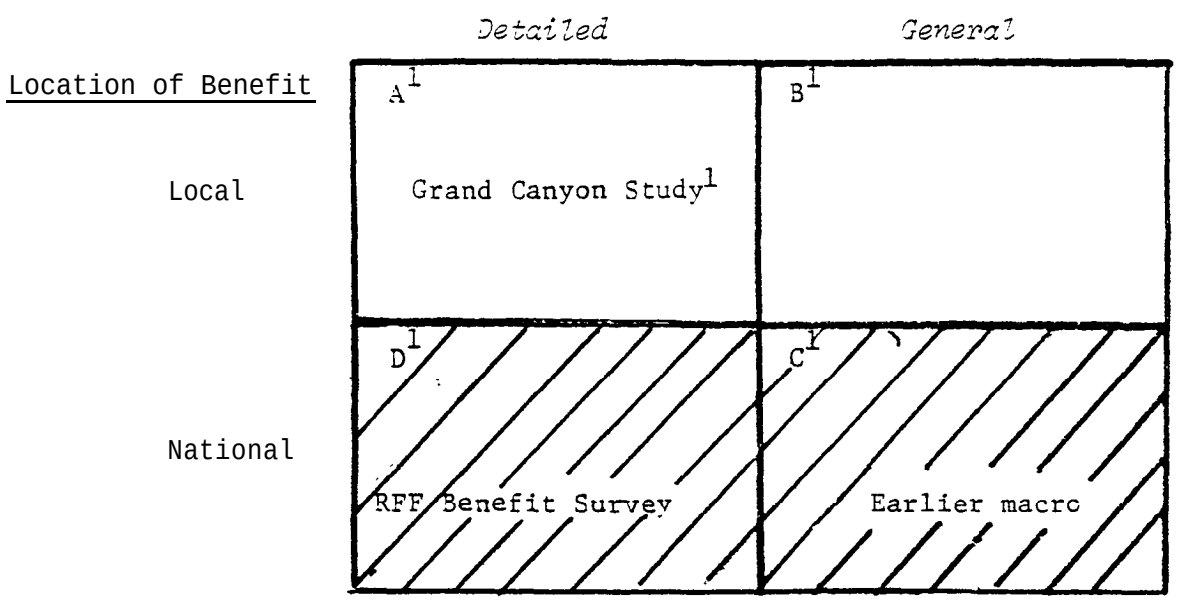
Figure 2

TYPOLOGY OF WILLINGNESS TO PAY STUDIES

Local Sample



National or Non-local Sample



[1] See footnote 1, page 2-4.

Chapter 3

RESEARCH PROCEDURES

The data for our test of a macro approach to estimating intrinsic water quality benefits was gathered in 1576 personal interviews of a national probability sample of persons 18 years of age and older. The sample was designed and the interviews were conducted by the Roper Organization. Interviewing took place in two waves: 1289 people were interviewed in late January - early February 1980 and 287 in March 1980.[1] The sampling plan was a multistage probability sample. Once an eligible person was identified, as many as four attempts were made to arrange an interview. Seventy-three percent of the individuals selected were ultimately interviewed. A description of the sampling design is contained in Appendix V.

For the entire sample, the chances are 95 out of 100 that the results on a particular question are within 2 to 3 percentage points of the results that would have been obtained from a very large sample selected and interviewed in a similar manner.

National surveys are very expensive to conduct. We were able to minimize the costs of this experiment by taking advantage of an ongoing survey. After the interview for the original survey was completed, the interviewers administered our sequence of benefits questions. From the respondents' perspective, the two interviews appeared as one long interview.

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[1] It was originally intended that all the interviewing would be done in the initial period, but the survey contractor had an unanticipated shortfall in interviews which went unrecognized for a month. This necessitated further interviewing to bring the sample up to 1500.

While this procedure allowed us to have our instrument field tested in a way that was completely satisfactory, budgetary constraints limited the number of questions we could ask and prevented us from preparing a set of briefing materials for the interviewers. Consequently, as will be discussed at length in later chapters, the percent of respondents who failed to give the interviewers the amount they were willing to pay for the levels of water quality was high, as was the percent who gave zero bids. In this chapter we describe the context of the survey and the instrument. Subsequent chapters discuss the reliability and validity of the responses and the values people have for water quality. The final chapter presents a plan for revising the procedures to improve the measures and increase the response rate to the wtp questions.

Context

The RFF water benefits questions took about 10-15 minutes to administer. They were preceded by a separate half-hour survey on environmental issues which was conducted for another study. Since the questions for this other study set the context for the water benefit questions it is important to outline briefly their content and results.

We will discuss the possible biasing effect they may have had at a later point in this report.

The environmental survey consisted of some 100 items which probed the respondent's views about national priorities, environmental protection, the regulation of risks, energy issues, values, and views about government and the environmental movement. A number of these items were repeated from earlier surveys for trend purposes. This survey sought to probe beneath the respondent's presumed predisposition towards environmental protection (as consistently shown by other national surveys) by asking questions which: a) forced the respondent to rank order the environment among other national priorities, b) measured concern about economic issues and energy shortages, and c) which forced the respondent to choose between tradeoffs (e.g. environment vs. growth or environmental quality vs. lower cost of regulation). The questionnaire for the environmental survey which preceded the benefits questions, including the background questions used for both studies, is in Appendix IV.

When the respondents were forced to rank order problems in terms of which should have the most government priority, "reducing pollution of air and water" fell to sixth place (out of 10 problems) from the second place position it held at the time of the original Earth Day in 1970. Responses to other questions in the environmental survey showed the respondents were extremely concerned about inflation, energy problems, and defense. Nevertheless, while the environment is apparently no longer viewed as a crisis issue, overall support for environmental protection showed continued strength in the trend and tradeoff questions, a finding confirmed by subsequent surveys.[2]

[2]For a description of the findings of the environmental survey see Public Opinion on Environmental Issues (Council on Environmental Quality, 1980).

The data from the environmental survey are part of our benefits data file and were used in our analysis of the benefits data. The environmental survey included several questions about water quality issues. The respondents were asked:

1. How worried or concerned they are with "cleaning up our waterways and reducing water pollution." Thirty-nine percent said they were concerned "a great deal," and at the opposite extreme 16 percent said they were concerned not much or not at all about water pollution. (See Q.11c, Appendix IV for the marginals and comparisons across other areas of concern in 1980).
2. Their judgment about the quality of the water in the "lakes and streams in this area" on a self-anchored 11 step ladder for the present, past (five years ago) and the future (five years from now). Q.18-20. From this set of questions it is possible to calculate their optimism or pessimism about change in local water quality over time.
3. How far in miles the nearest freshwater lake and river large enough for boating are from their home (Qs. 33a and b).
4. A series of questions on use of water (Qs. 58-66) For boating, swimming and fishing in a freshwater lake or stream, respondents were asked whether they had engaged in each activity in the past two years, if so whether they did it within fifty miles of their home, and how many times they did it during this time period. We used these questions for our measures of recreational water use.

Water Pollution Ladder and Value Levels

The levels of water quality for which we sought WTP estimates are "boatable," "fishable," and "swimmable." We described these levels in words and depicted them graphically by means of a water quality ladder. Use of these categories, two of which are embodied in the law mandating the national water pollution control program, allowed us to avoid the methodological problems we would have faced had we chosen to describe water in terms of the numerous abstract technical measures of pollution. Although the boatable-fishable-swimmable categories are widely understood by the public, they did require further specification on our part to ensure that people perceived them in a similar fashion.

We defined boatable water in the text of the question as an intermediate level between water which "has oil, raw sewage and other things in it, has no plant or animal life and smells bad" on the one hand and water which is of fishable quality on the other. Fishable water covers a fairly large range of water quality. Game fish like bass and trout cannot tolerate water that certain types of fish such as carp and catfish flourish in. In our pretests we initially experimented with two levels of fishable water -- one for "rough" fish like carp or catfish and the other for game fish like bass -- but we were forced to abandon this distinction because people were confused by it. We adopted a single definition of "fishable" as water "clean enough so that game fish like bass can live in it" under the assumption that the words "game fish" and "bass" had wide recognition and connoted water of the quality level Congress had in mind. Swimmable water appeared to present less difficulty

for popular understanding since the enforcement of water quality for swimming by health authorities has led to widespread awareness that swimming in polluted water can cause sickeness to humans.

Because WTP questions have to describe in some detail the conditions of the "market" for the good they are inevitably longer than the usual survey research questions. Respondents quickly become bored and restless if material is read to them without giving them frequent opportunities to express judgments or to look at visual aids. We designed the RFF instrument to be as interactive as possible by interspersing the text with questions which required the respondents to use the newly described water quality categories. We also handed them a water quality ladder card which was referred to constantly during the sequence of benefits questions.

Figure 3.1 shows the card. The ladder is similar to the self-anchoring ladder used earlier in the interview. The top, step 10, was called the "best possible water quality" and the bottom, step 0, was the "worst possible water quality." This time, however, we anchored it by designating five levels of water quality at different steps on the ladder. Level E, at .8, was specified as a point on the ladder where the water was even unfit for boating although the active range below 2.5 was described as being of this quality. Level D, 2.5, was where it became okay for boating; C at 5 was fishable, B at 7 was swimmable and 9.5 was identified as A where the water is safe to drink. These numerical positions were estimated by indexing a set of five objective scientific water quality parameters using a variant of the National Sanitation Foundatin's Water Quality Index (Booth et al.,

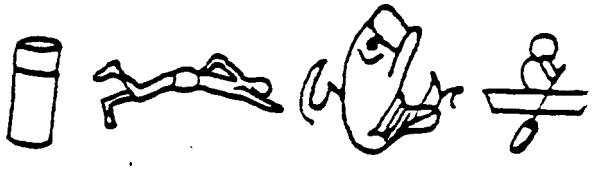
Figure 3.1

B (WATER QUALITY LADDER CARD) #684

BEST POSSIBLE
WATER QUALITY

10

A SAFE TO DRINK



9

8

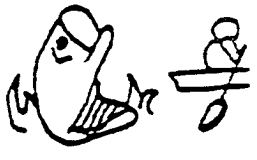
7

B SAFE FOR SWIMMING

6

5

C GAME FISH LIKE BASS CAN LIVE IN IT



4

3

D OKAY FOR BOATING

2

1

E

0

WORST POSSIBLE
WATER QUALITY

1976; McClelland, 1974). The method is described in Appendix II. Although this is necessarily a tenuous scaling procedure, it yielded a set of positions which appear reasonable. Our pretests showed that respondents did not seem to be sensitive to changes of one or two rungs in the location of the water quality levels along the scale.

We introduced the market and the ladder in the following manner:

> This last group of questions is about the quality of water in the nation's lakes and streams. Comgress 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

We thus defined the environmental good as freshwater lakes, rivers and streams and distinguished it from drinking water and salt water. We specifically invoked visual values as well as the active use values of boating, fishing and swimming.

Our intention was to obtain a WTP estimate for national water quality. In order to get the respondent to think about the national situation the interviewer next asked:

> 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?

Strictly speaking, the law mandates water cleanup for all freshwater bodies. We substituted "all but a tiny fraction" for "all" in this and the following questions because we did not want to unnecessarily complicate the issue by having respondents speculate about the impossibility of every portion of every water body in the nation being at a certain water quality level at all times. Six out of ten respondents agreed that today all but a fraction of the nation's freshwater bodies are at level D while 17 percent were not sure and 20 percent felt that level had not yet been reached.

The next section of the instrument was meant to introduce the respondent to two things: 1) the fact that water pollution control costs money and 2) that the level of cleanup is a matter of preference. We did this by asking the following question:

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?

Eighty-five percent chose a goal of fishable or better (C, B, or A) while 57 percent chose swimmable or better (B or A).

Payment Vehicle

We used two principal criteria to choose our payment vehicle. The first is realism -- the vehicle should match the way people actually pay for higher water quality as closely as possible. The second criteria is conservativism -- every effort should be made to avoid a false overstatement of willingness to pay. Conservativism in question design is important because unless respondents are made to pay the amounts they offer, WTP studies are inevitably hypothetical in character. The bias associated with hypothetical situations is towards overstating the amount the person is willing to pay[3] although the amount of overstatement is not necessarily large (Bohm, 1972) and is sometimes nonexistent (Davis, 1980). Given many economists' fear that the WTP methodology is biased upward, the findings of WTP questions will be credible only if every effort is made to avoid this bias. Our procedure was to design our instrument so that, whenever possible, any bias present is toward lowering rather than raising the WTP amount.

We selected annual household payment in higher prices and taxes as our payment vehicle because this is the way people pay for water pollution control programs. A portion of each household's annual federal tax payment

[3] See Chapter 4.

goes towards the expense of regulating water pollution and providing construction grants for sewage treatment plants. Local sewage taxes pay for the maintenance of three plants. Those private users who incur pollution control expenses, such as manufacturing plants, ultimately pass much or all of the cost along to consumers in higher prices. This payment vehicle is conservative because:

- Ever since the passage of Proposition 13 in California in 1977, opposition to the current level of taxes is a commonly expressed attitude which is socially acceptable (even normative). Concern about inflation was the nation's "most important problem" according to polls taken at the time of the RFF survey. Thus we can assume the words "taxes and higher prices" will not be taken lightly by our respondents and may, for some, have a highly charged negative connotation.
- By asking for the annual amount a person is willing to pay instead of for a monthly amount, we avoid the possibility of an “easy payment plan" underestimation.

Starting Point

Our review of the literature on micro WTP studies and on survey research more generally, identified starting point bias as a particularly serious problem for our study. Because of this we developed and tested an alternative to the commonly used bidding game WTP method. In this section we outline the problems presented by the bidding game technique and describe our alternative procedure -- the payment card method.

The widely used bidding game format for WTP studies uses a sequence of yes/no questions and normally requires the interviewer to begin the bidding process by offering an initial amount. The subsequent bids flow from that point, albeit in either direction. If the amount presented influences the respondent's final bid in some systematic way -- starting point bias -- we have a serious problem.

There are a priori reasons for suspecting such a bias in this type of situation. The tendency of respondents to give a socially desirable answer (Edwards, 1957; Dohrenwend, 1966; Phillips and Clancy, 1970, 1972) or to acquiesce when confronted with questions using a yes/no agree or disagree format (Couch and Keniston, 1960; Campbell et al., 1967; Carr, 1977; Jackman, 1973; and Phillips and Clancy, 1970) is well documented. Accordingly, when valuing a public good like water quality, a respondent may be reluctant to reject a starting bid even when it is higher than he is willing to pay for fear of appearing cheap or lacking a social conscience (social desirability effect) and/or because of a tendency on the part of the respondent to agree with suggestions offered by the interviewer (acquiescence effect).

In practice, strong starting point effects have been found by some researchers doing micro WTP studies (Rowe et al., 1979) although other researchers have not found them (Thayer, et al., forthcoming; Brookshire, et al., 1979; Brookshire et al., 1980). Where starting point bias has been discovered, the effect of higher starting points is to raise the mean WTP amount.

The acquiescence effect shows a strong relationship with education -- people with less education are much more likely to acquiesce than those with more education (Jackman, 1973). This introduces a further bias. If we assume, as studies have shown, that WTP varies by income level and that income is correlated with education, then the potential for an education/ WTP interaction effect is strong when a single starting point is used for the entire sample. When choosing a single starting point, the researcher needs one that will be below the expected mean for the entire sample, but not too far below or the process of bidding upward to find the maximum WTP amount will be too laborious. An initial bid which meets this requirement for the entire sample can be expected to be below the mean for people in the $15-25,000 range, close to the mean of the real bid for someone in the $8,000-14,999 income range and above the real mean bid for those with lower incomes. Since many people in the lower income range will also have low educations, in this situation they are likely, by the operation of the acquiescence effect, to overbid for the good in question. The reverse is less likely to happen for those with an income above $25,000 because their educational level is higher (on the average) and therefore their propensity for acquiescence in the interview situation is lower. Thus even if the overall starting bias described earlier is not present, overstatement of benefits by lower income people will bias the WTP amounts upwards.

A further problem with the bidding game technique is that the process of iterating from a starting point to a final WTP amount can be tedious if the starting point lies some distance from the respondent's real WTP amount. If the range is narrow -- such that most respondents, for example,

value a certain good at between $1 and $5 per month on their utility bill -- and if the increments are fairly large -- say $1 -- then the process can be accomplished fairly efficiently. When this is not the case, the length of the iteration process can alienate respondents or cause them to cease bidding before reaching their maximum amount.

The problems with the bidding game approach enumerated above are exacerbated for payment vehicles like ours which engender large bids (because they ask for an annual household amount for national water quality) and which are strongly income dependent (owing to the income tax component of the vehicle). Moreover, it seems questionable that the bidding game technique can be used reliably by professional interviewers such as ours who are spread across the country and cannot be personally instructed in its use. For these reasons we developed our payment card technique to elicit the respondent's WTP amounts.

In this technique the respondent is given a card which contains a menu of amounts which begin at $0 and increase by a fixed interval until an arbitrarily determined large amount is reached. When the time comes to elicit the WTP amount, the respondent is asked to pick a number off the card (or any number in between) which "is the <u>most</u> you would be willing to pay in taxes and higher prices <u>each year</u>" (italics in the original) for a given level of water quality. The question asks people to give us the highest amount they are willing to pay and we accepted their answer as representing such an amount. In our pretesting we tried asking people if

they would be willing to pay a higher amount than the one they picked and found some people resented being "pushed" once they had settled on an amount. Others would give us a higher amount but in such a way that we suspected they were acquiescing to interviewer pressure rather than revealing their true consumer surplus.

The payment card has two special features:

1. It is anchored. In our initial pretests we found the respondents had considerable difficulty in determining their willingness to pay when we used a card which only presented various dollar amounts. A number of them expressed embarrasment, confusion, or resentment at the task and some who gave us amounts indicated they were very uncertain about them. We determined that the problem lay with the lack of benchmarks for their estimates. People are not normally aware of the total amounts they pay for public goods even when that amount comes out of their taxes, nor do they know how much they cost. Without a way of psychologically anchoring their estimate in some manner they were not able to arrive at meaningful estimates. They needed benchmarks of some kind which would convey sufficient information without biasing their WTP amounts. We reasoned that the most appropriate benchmarks for WTP for water pollution control would be the amounts they are already paying in higher prices and taxes for other non-environmental public goods. We identified amounts on the card for several such goods and conducted further pretests. These showed the benchmarks made the task meaningful for most people.

The use of payment cards with benchmarks raises the possibility of information bias. Are the respondents who gave us amounts for water pollution

control using the benchmarks for general orientation or are they basing their amounts directly on the benchmarks themselves in some manner? In the former case people would be giving us unique values for water quality; in the latter case they would be giving us values for water quality relative to what they think they are paying for a particular set of other public goods. If the latter case holds and their water quality values are sensitive to changes in the benchmark amounts or to changes in the set of public goods identified on the payment card, their validity as estimates of consumer surplus for water quality are suspect.

We designed our study to test for information bias due to the benchmarks. Four different versions of the payment cards were prepared and administered to approximately equivalent sub-samples. Figures 3.2 shows the cards given to the lower-medium income respondents ($10,000-14,999 annual family income) for the A, B, C, and D versions. These versions varied as follows:

A Benchmarks are shown for the amounts we estimated the average household of that income level contributes to the space program, highways, public education and defense.

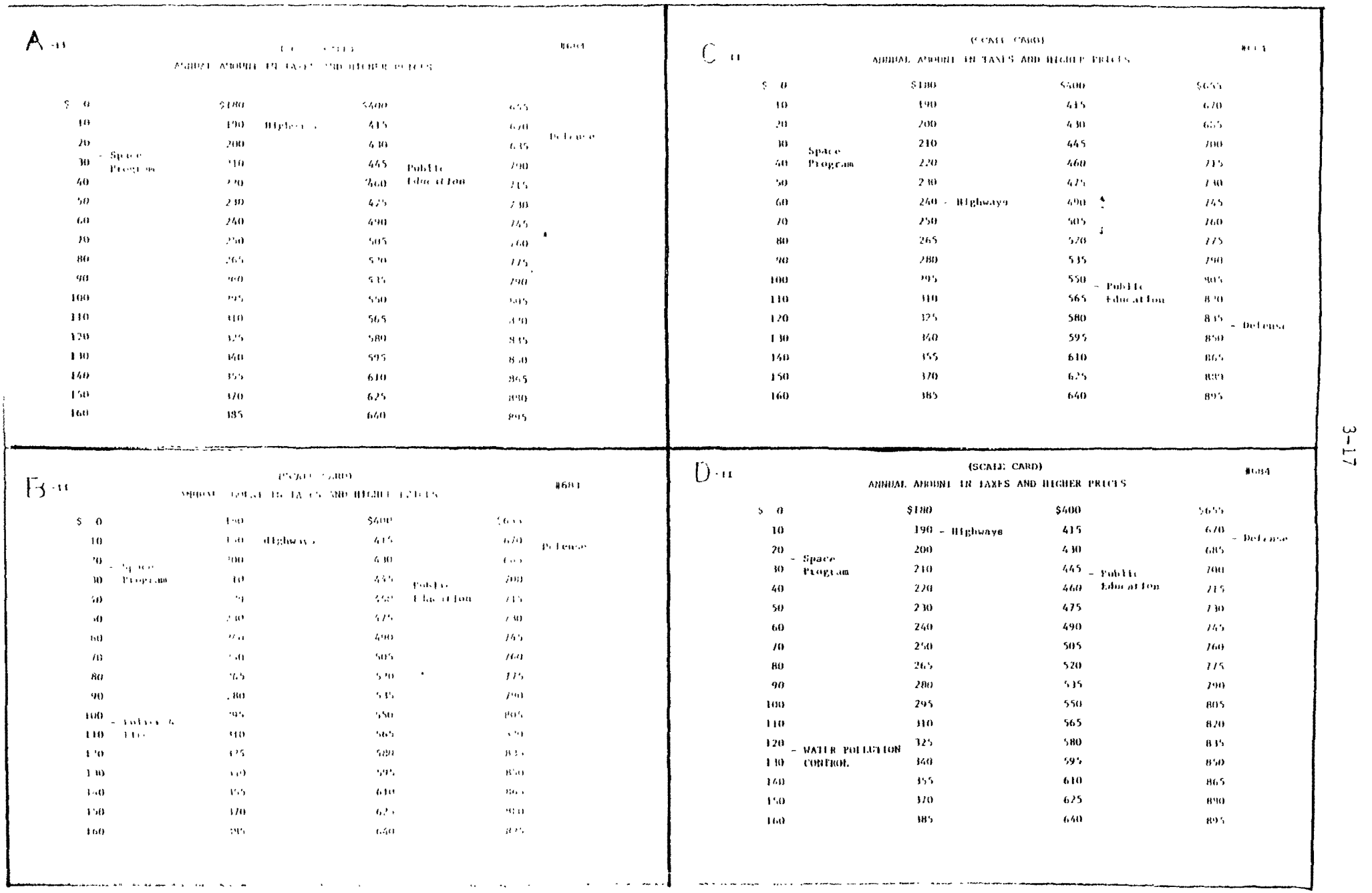
B The same four public goods and amounts as on A plus police and fire protection.

C The same four public goods used in version A were shown, but for amounts 25 percent higher than on version A.

D The same four public goods and amounts as in Version A, plus the estimated amount for water pollution control.

We added the police and fire good in version B to see if the insertion of a new item in the dollar range where water pollution benefits estimates were likely to fall would affect those estimates. Version C seeks to test whether the actual amounts shown for the benchmarks affect the water pollution WTP amounts. We purposely omitted environmental goods in each of the

Figure 3.2 PAYMENT CARDS FOR VERSIONS A, B, C, D FOR PEOPLE WITH FAMILY INCOMES OF $10,000-14,999



first three versions to avoid having people would tell us what they think they should give rather than what they actually want to pay. In version D we added our estimate of what average households are actually paying for water pollution control to see whether this information actually does bias the WTP amounts.

Deriving the dollar estimates for each of our benchmark public goods was a difficult task particularly because we needed them for four income levels as well (see below). A detailed description of our procedures is given in Appendix III. We are satisfied that the estimates are sufficiently close approximations to suffice for this test. If it turned out that people's WTP amounts are very sensitive to the benchmark amounts, then much more effort would be required to improve the accuracy of these estimates.

2. It is income adjusted. For the reasons stated earlier, the amounts people are actually paying for water pollution control vary by income. This is also the case for the other public goods which we used as benchmarks. We corrected for this by developing benchmark goods estimates for four different income categories: I) family income under $10,000; II) $10,000-14,999; III) $15,000-24,999; IV) $25,000 and above. (Appendix I gives our public goods estimates for each of these income categories). Each interviewer therefore had four different payment cards for each of the A, B, C, and D forms. At the appropriate point in the interview the interviewer gave the respondent the payment card for his or her income category. (A question on income preceded the water quality benefits questions.) For the 10 percent of respondents who refused to divulge their income our procedure was to give them the income card for income level IV, the highest income level as people with higher incomes are more likely to refuse to divulge their income.

Figure 3.3 gives the four forms used for Version A. The card for the lowest income category (I) shows an annual defense figure of $325 while those in the highest income category were told they are spending between $3000 and $3075 per year on defense. In order to make the stimuli shown on the payment cards as similar as possible to each of the four income groups we varied the range of potential amounts. Each card shows 60 amounts. Income category I's amounts ranged from $0 to $440 while those for IV were $0 to $3285. These ranges and the intervals (which are wider at the higher levels) were chosen so that the visual pattern of public goods amounts was approximately the same for each income level. In each case the maximum amount on the card is roughly 30 percent greater than the amount shown for defense.

The following is the text of the first WTP question in our instrument. The same text was used for versions A, B, and C with the exception of the additional mention of police and fire in paragraph two for version B.

> 82. Improving the quality of the nation's water is just one of many things we all have to pay for as taxpayers 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.

Figure 3.3 PAYMENT CARDS FOR INCOME LEVELS I-IV FOR VERSION A

A-I

(SCALE CARD)

#684

ANNUAL AMOUNT IN TAXES AND HIGHER PRICES

$ 0	$ 75	$150	$300
5	80	160	310
10	85	170	320
15	90	180	330
20	95	190	340
25	100	200	350
30	105	210	360
35	110	220	370
40	115	230	380
45	120	240	390
50	125	250	400
55	130	260	410
60	135	270	420
65	140	280	430
70	145	290	440

- Space Program
- Highways
- Public Education
- Defense

A-II

(SCALE CARD)

#684

ANNUAL AMOUNT IN TAXES AND HIGHER PRICES

$ 0	$180	$400	$655
10	190	415	670
20	200	430	685
30	210	445	700
40	220	460	715
50	230	475	730
60	240	490	745
70	250	505	760
80	265	520	775
90	280	535	790
100	295	550	805
110	310	565	820
120	325	580	835
130	340	595	850
140	355	610	865
150	370	625	880
160	385	640	895

- Space Program
- Highways
- Public Education
- Defense

A-III

(SCALE CARD)

#684

ANNUAL AMOUNT IN TAXES AND HIGHER PRICES

$ 0	$270	$ 660	$1200
15	285	690	1230
30	300	720	1260
45	315	750	1290
60	330	780	1320
75	345	810	1350
90	360	840	1380
105	375	870	1410
120	390	900	1440
135	405	930	1470
150	420	960	1500
165	450	990	1530
180	480	1020	1560
195	510	1050	1590
210	540	1080	1620
225	570	1110	1650
240	600	1140	1680
255	630	1170	1710

- Space Program
- Highways
- Public Education
- Defense

A-IV

(SCALE CARD)

#684

ANNUAL AMOUNT IN TAXES AND HIGHER PRICES

$ 0	$450	$1200	$2550
25	475	1275	2625
50	500	1350	2700
75	525	1425	2775
100	550	1500	2850
125	575	1575	2925
150	600	1650	3000
175	625	1725	3075
200	650	1800	3150
225	675	1875	3225
250	700	1950	3300
275	725	2025	3375
300	750	2100	3450
325	775	2175	3525
350	800	2250	3600
375	875	2325	3675
400	950	2400	3750
425	1125	2475	3825

- Space Program
- Highways
- Public Education
- Defense

> 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.

Several aspects of question 82 bear comment. For the purpose of convenience we started the process of demand revelation with the present level of national water quality (boatable) and asked respondents to value a reduction in this quality to level E, non-boatable. (In subsequent questions we had them value hypothetical increases from boatable to fishable and then swimmable.) In this question we expanded the account given in the previous questions about how their money would be used and reinforced the ideas that the WTP amount would be coming out of their annual income and its use for this purpose would preclude other uses of the money. At two points in this question we legitimated a low or zero WTP amount in an effort to minimize the social desirability effect. We noted that "people have different ideas" about the importance of water quality to them personally

and at the conclusion of the question we stated: "If it is not worth anything to you, please don't hestiate to say so."

The response categories which were supplied to the interviewers for this question were:

Write in amount: $_____

Depends (voluntary)

Not sure

Not worth anything

Through a misunderstanding the survey contractor did two things which may have biased the results. First in this and the next question, those who responded "not worth anything" -- in effect a $0 bid -- were not asked how much they were willing to pay for water of higher quality. Instead, the interviewers skipped directly to the last question. Presumably most of the people who valued boatable water at $0 were generally unwilling to pay for water pollution control of any kind and would also have valued fishable and swimmable quality water at $0. Our analysis of the views of these people about water pollution and environmental quality suggests that this conjecture is probably true for most of them. But some of them may indeed only value water nationwide when it reaches the fishable and/or swimmable quality levels. If so, they would have given a WTP amount greater than $0 for the higher levels, if they had the opportunity, despite their $0 bid for the lower level. Second, when the data were keypunched, the contractor restricted the WTP amounts to three colums, thereby limiting the maximum WTP amount to $999. For versions A, B, C combined, 43 People

were recorded as WTP this maximum amount for level B. We have no way of knowing how many of these people actually valued water quality at an amount higher than this. It is our judgment that both these errors have had only a minor effect on our estimates. The direction of the resulting bias is, of course, conservative.

The next question sought the respondents' WTP for fishable water, level C.

> 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?

The final WTP question used the same format for swimmable water, level B.

> 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?

In two of the versions, A, and C, we asked the respondents to evaluate the amount of information we provided them about the WTP exercise. We were precluded from asking this of all the respondents because of severe constraints on the length of the questionnaire.

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?

CHAPTER 4

CONTROL FOR BIASES

Prior to discussing our findings it is necessary to examine the character of the data we have gathered. To what extent are they free from bias? The micro willingness-to-pay literature has devoted considerable attention to the potential biases, their effect and how they may be overcome (Schulze, et al., 1980). Table 4.1 lists these potential biases and several others which we believe to be important.

Table 4.1

POTENTIAL BIASES IN WILLINGNESS TO PAY STUDIES

General	Sampling
Strategic	Sample
Hypothetic	Response Rate
Instrument	**Interview**
Starting Point	Item non-response
Payment Vehicle	Interview Procedure
Information	Interviewer
Order	

GENERAL BIASES

Strategic and hypothetic are the two sources of bias of greatest fundamental concern to economists who wish to evaluate the validity of willingness to pay surveys.

Strategic Bias

Its Nature

Strategic bias is the attempt by respondents to influence the outcome of a study in a direction which favors the respondents' interests by deliberately misrepresenting their demand for a good.[1] In 1954, Paul Samuelson argued on free-rider grounds that a person would be motivated to "pretend to have less interest in a given collective consumption activity than he really has" and despaired of finding a way of overcoming this problem (1954). Samuelson assumes that the individual would believe he or she would have to pay the amount he or she declares as being willing to pay. If this assumption is relaxed, as seems reasonable, many economists believe an incentive to overestimate consumption would be prevalent (Freeman,19796:88). For example, take a survey whose respondents believe the mean WTP amount for all respondents will influence the government's provision of a public good and that they will not be obligated to pay their WTP amount. If they value the good, the respondents may attempt to raise the mean (and impose their preference) by overstating their willingness to pay. Robert Crandall seems to have this kind of situation in mind when he wrote: "Such surveys (consumer

[1] See Kutz (1975) for the the theoretical conditions necessary for successful strategic behavior.

surveys) are always biased when the respondent knows that he or she does not have to write a check to confirm the answer" (Crandall, 1979). Conversely, those who do not value the good very highly but assume that many others do, may underestimate their willingness to pay in order to lower the mean and bring it closer to their actual willingness to pay.

Empirical attempts to test for strategic bias in willingness to pay studies and laboratory experiments have consistently failed to find it (Brookshire, et al., 1979:22-23; V.L. Smith, 1977). A much cited challenge to the notion that strategic bias can be overcome in WTP studies is an experiment conducted by Peter Bohm. In one of the few attempts to compare hypothetical WTP questions with the results from identical non-hypothetical situations, Bohm (1972) conducted an experiment where participants bid for the opportunity to see a closed circuit television program. He ran six different versions of the experiment most of which systematically introduced incentives to act strategically in a situation where the respodent actually had to pay their bids. Only one version, Group VI, gave bids which were significantly different from any of the others. Since this group was told that they would not actually have to pay what they bid, Bohm draws the conclusion that "when no payments and/or forced decisions are involved people will act in an irresponsible manner" (Bohm, 1972:125). In other words, when the consequences for respondents are hypothetical they will overbid. Careful examination of Bohm's study shows that this conclusion is unwarranted:

1. Out of five comparisons, Group VI's mean bid was significantly higher in only one case (Group III).
2. Group VI was higher in income than the other groups which may account for the size of its mean payment.
3. Group V also did not have to pay its bid. If strategic bias was operative, there are reasons to think that this group should have had the highest bid of all, but it did not.
4. Unlike the other groups, Group VI had one high outlier (at 50 where the median bid was 10) which raised its mean bid considerably. When the outlier is removed, its mean payment is reduced from 10.19 to 9.45 Kroner and the difference between Group VI and Group III drops below the .05 level of significance. It would appear that only one person of 54 may have acted "irresponsibly." [2]

The incentives to misrepresent preferences are minimal in most WTP surveys because respondents lack either the information necessary to act strategically or the incentive to do so because respondents do not believe they will be directly affected by the study's outcome. Although respondents take valuation questions seriously, most do not think their responses will have an immediate effect on policy nor should they since policy has rarely, if ever, been set in this manner. The now conventional wisdom on strategic bias in WTP surveys was recently summarized by Feenberg and Mills in their recent review of water benefit analysis. They concluded, "It is unlikely that the problem is serious" (Feenberg and Mills, 1980).

[2] We do not believe the one person acted strategically since an incentive to overbid in this situation was not apparent although our colleague, Clifford Russell, believes this to be an example of strategic bias.

Our instrument was designed to minimize possible incentives to engage in strategic behavior. No policy outcome was mentioned in the instrument nor were respondents told how their WTP amounts would be used. Even if respondents inferred that the study's findings are intended for government guidance in some way, most would be aware of the indirect connection between such a study and the actual process by which tax rates and prices are determined. On a priori grounds, therefore, we would not expect strategic bias to affect our results.

(continue)

Distribution Tests for Strategic Bias

Apart from specific experimental tests, two possible indicators of strategic bias, neither of them formalized, have been suggested, A distribution test was first proposed by Brookshire, Ives and Schulze (1976). They hypothesized that the distribution of the WTP amounts (in their case, bids) will be normal when strategic bias is absent. If it is present, they predict a "flattened" distribution. They examined the distribution of responses for their study, which involved the aesthetic benefits of foregoing the siting of a power plant near Lake Powell, and concluded on the basis of observation that since the distribution was "not flat," strategic behavior was unlikely.

This distribution test has several weaknesses.

1. Even if we accept the notion that non-strategically biased distributions should be normal it is impossible for most WTP distributions to pass the standard statistical tests for normality such as the Komogorov-Smirnov test.[2] These tests assume that each data point has an equal probability of being chosen, but since respondents tend to choose favorite numbers (e.g., 5, 10, 20, 25 rather than 6, 11, 22, etc.), the resulting distribution is always too lumpy to pass the test even though the distribution may appear to approximate a normal distribution.

[2]Clifford Russell has recently called our intention to a grouped data normality test (Burlington and May, 1958:180-181) which may be an appropriate normality test for these kinds of data.

2. The expectation that strategic behavior will flatten an otherwise normal (or approximately normal) distribution is well founded, but only if the distribution of those who value the public good in question is normally distributed. In certain situations there is reason to doubt that non-biased WTP amount distributions will be normal. Imagine a population, most of whom are either environmental enthusiasts or enthusiasts for industrial growth at the lowest possible cost. If they all act strategically, we will get a bi-modal rather than a flat distribution with the environmentalists' amounts accumulating at the high end and the industrial enthusiasts' at the other end.

3. Since income is the primary deterrent of willingness to pay and since the distribution of income more clearly approximates a log normal curve[3] than the normal curve. In the absence of strategic bias, the distribution one would expect in this situation would be closer to a log-normal than a normal distribution.

Figure 4.1 gives the distribution of the WTP amounts for fishable (level C) water for questionnaire versions A, B, and C combined.[4] the distribution is

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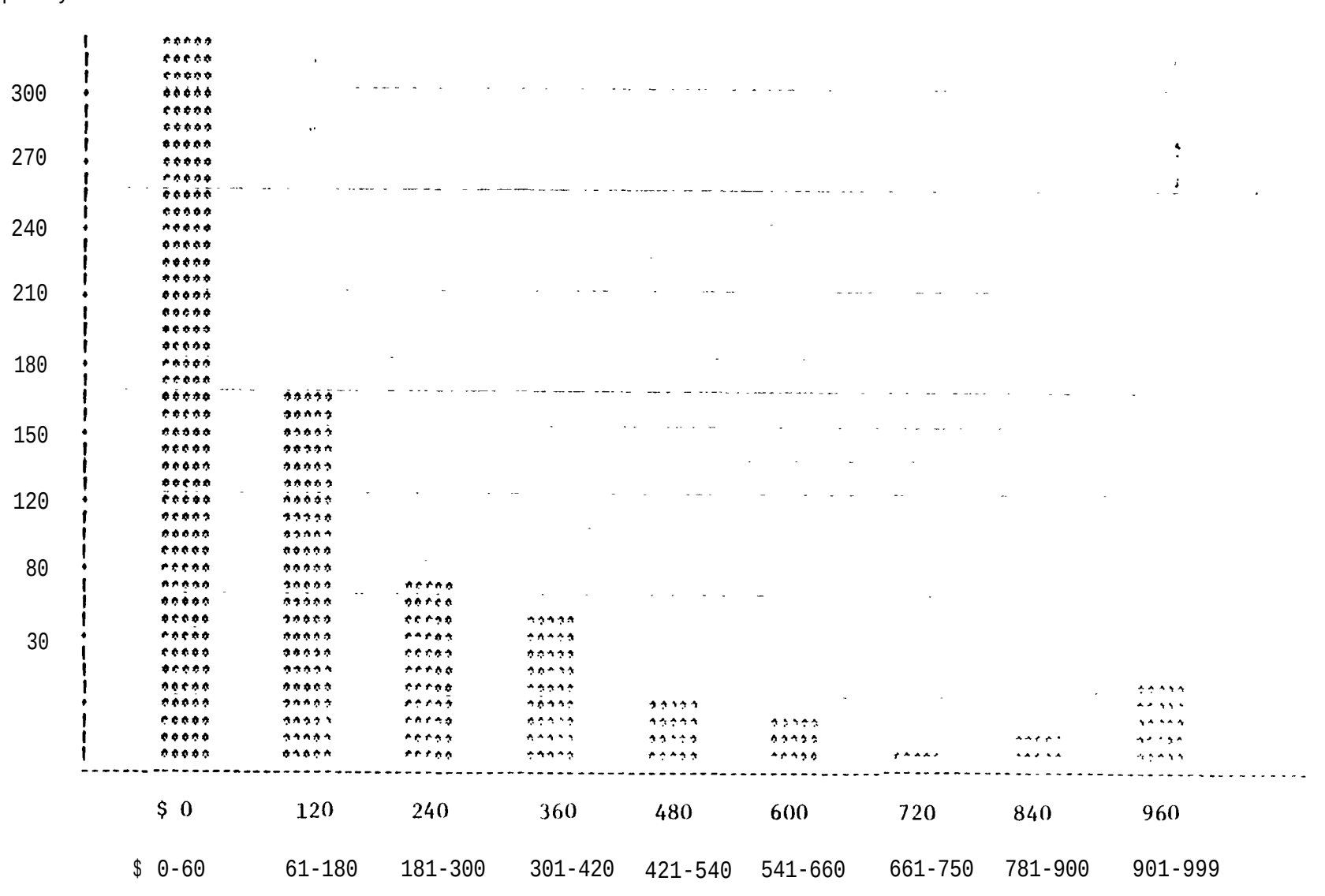
[3]According to O'Brien (1979:855) the log-normal distribution is somewhat more skewed than the distribution of income in the United States.

[4]Unless otherwise specified, we will normally combine the results for three versions, for reasons to be explained below. Whenever we report the results for one level, we will use C, fishable water. Unless otherwise specified, the results for the other levels (boatable, swimmable) parallel those for fishable.

Figure 4.1

DISTRIBUTION OF WTP AMOUNTS FOR FISHABLE WATER
FOR VERSIONS A, B, C COMBINED INCLUDING ZERO AMOUNTS



dominated by the WTP amounts in the lowest category, $0-60. Of these, more than half are zero bids. The high occurrence of zero bids is one of the two major problems with our method revealed by our experiment (the other being the relatively high percent of people who failed to give any WTP amount). It is a problem because it seems likely that most of those who gave zero bids actually have a greater than zero value for water quality and would be willing to pay some amount, however small, for water pollution control if we had an improved way of eliciting their true preferences. By probing zero responses, other studies have found that some of those who give zero WTP amounts do so to protest some aspect of the interview situation. This is undoubtedly the case in our situation, but we were

(continue)

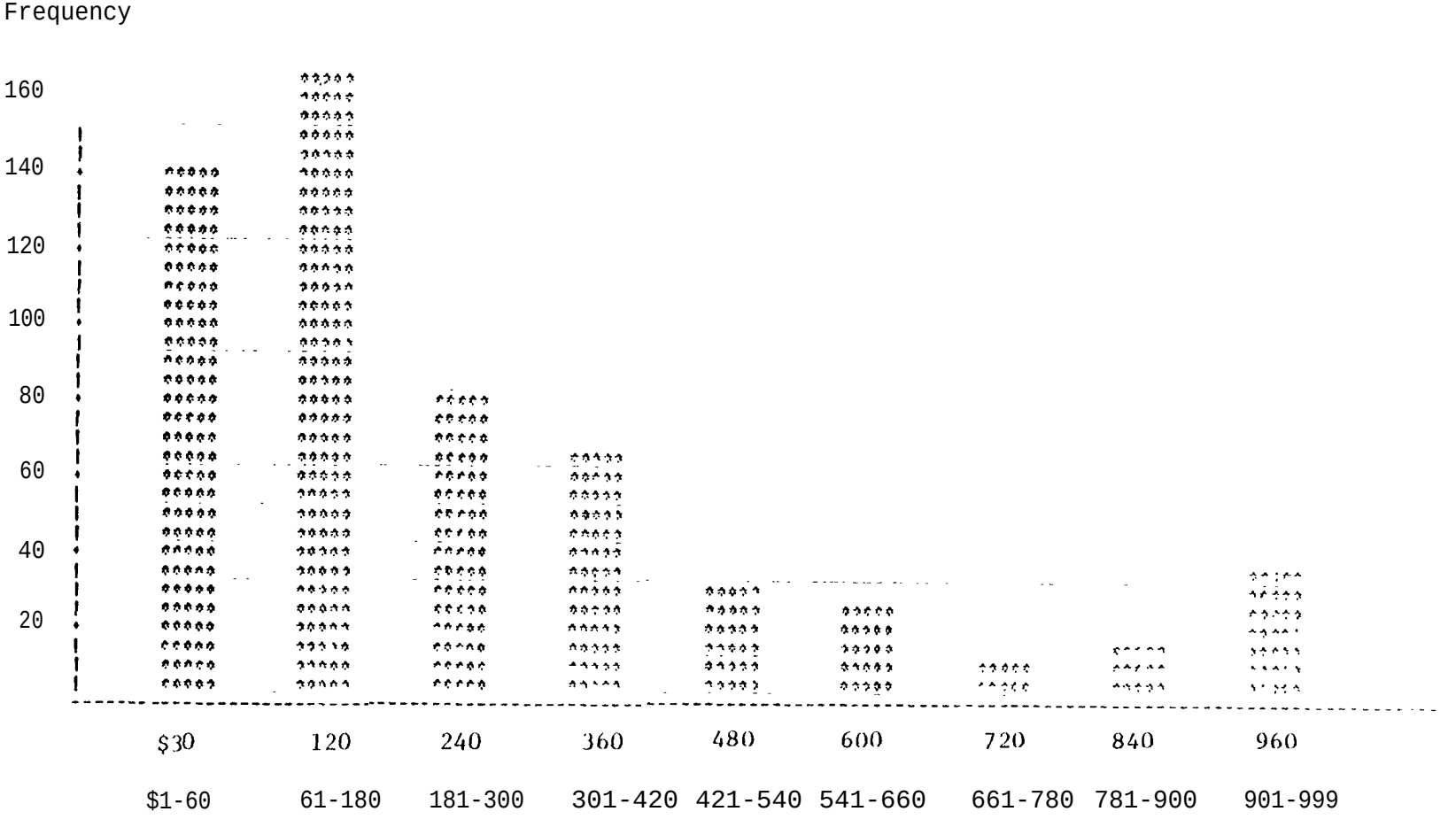
unable, for the reasons discussed in Chapter 3, to probe our zero bidders to learn the reasoning behind their amounts. (We discuss the problem of zero bidders in detail later in this chapter under item non-response bias.) Since we are unable to separate the "real" zero payers from the protest zero payers, our subsequent analysi includes all those who gave zero amounts. By doing this we bias our findings downwa by some indeterminate factor. However, for the sole purpose of examining the distribution of the WTP amounts, we recalculated the distribution leaving out all the zero amounts. The revised distribution is given in Figure 4.2.

1. At the upper end the distribution falls off until the highest category where it increases. This is caused in large part by the arbitrary $999 upper limit to our WTP amounts. Since most of those who gave this amount are in our highest income category, we believe that if the $999 constraint had not been introduced at the keypunching stage, the distribution would have tailed off gradually.

2. The overall shape of the distribution is not flat. It approximates a log normal distribution, a distribution similar to that reported by Brookshire, et al. (1976) in their Lake Powell study, and to the distribution of income in the United States. Since income is a strong predictor of people's willingness to pay for water quality, as we will see in Chapter 5, we conclude that the distribution does not suggest strategic bias.

Figure 4.2

DISTRIBUTION OF WTP AMOUNTS FOR FISHABLE WATER
FOR VERSIONS A, B, C COMBINED EXCLUDING ZERO AMOUNTS



A second method of testing the hypothesis that the distribtuion of WTP amounts will be "flatter" than normal when strategic bias is present is implied by Brookshire, et al. (1976) in their Lake Powell study when they make the following statements:

> ... false bids will be very large relative to the mean for environmentalists and zero for non-environmentalists where bids are constrained to be non-negative (1976:328).
>
> ... if strategic behavior had been prevalent one would expect a significant number of high bids relative to the mean bid (1976:340).

This test also has its problems. First, and most important, we have no objective way of identifying "false" values since the essence of the problem of preference revelation is that "true value is subjective and typically cannot be observed independently" (Freeman, 19796:97). Second, the simple fact that environmentalists are willing to pay more than other people for environmental goods (and non-environmentalists less) does not necessarily imply strategic behavior on their part, especially when the environmental good being valued is a broad one like the nation's water quality. If environmentalists are true to their professed ideals, we would expect them to be willing to pay more for water quality than those of comparable income who are less committed to environmentalist ideals.

Bearing these problems in mind, the best we can do is to arbitrarily define certain WTP amounts as inappropriately "high" or "low," relative to the respondents' income level, and see if a) the percentage of people who give bids of this kind is large enough to be troublesome and

b) if environmentalists and anti-environmentalists are disproportionately represented among those who give such bids in such a way that the results will be biased one way or the other.

Table 4. [2] divides those who gave us amounts for fishable water into four groups:

1. Those who gave zero.
2. Those who gave "low" amounts which we define as any amount above zero but equal to or lower than half the amount shown on the respondent's payment card as the amount contributed to the space program. For those in the lowest income group this is 1-6 dollars; for those in the highest this is 1-53 dollars.
3. Those who gave "high" amounts which we arbitrarily define as any amount equal to or greater than the amount shown for public education on their card. This amount was $204 for the low income group and S1695 for the high income group.
4. Those who gave an amount between the low and high extremes, who we label "normal."

Eighty-three percent of those who gave amounts greater than zero[5] fall into our "normal" category. Those in the extreme categories are divided, with 10 percent giving "high" amounts and 7 percent willing to pay low amounts. We conclude that those at the extremes are relatively few in number and rather evenly balanced.

The table also shows some of the characteristics of the people in each of these groups. Comparing those in the low category with the normals, the lows have a larger percentage of people in the highest income category

[5] Coding did not distinguish between zero and one dollar responses, which were both coded as zero (or, in log responses, as one).

Table 4.2

PERCENT OF THOSE GIVING VARIOUS LEVELS OF PAYMENT
WHO BELONG TO CERTAIN DEMOGRAPHIC AND ATTITUDINAL CATEGORIES

	Amount Willing to Pay for Fishable Water (level C)[1]				
	$0	"LOW"	"Normal"	"High"	Cave No Amount
Maximum N = [2]	(183)	(40)	(447)	(52)	(445)
A High Income[3]	13% (20)[4]	40% (16)	23%(101)	48% (25)	16% (57)
B Low Education:High School and Below	78 (143)	65 (26)	68 (275)	43 (22)	73 (328)
C Age 65 and Older	25 (46)	13 (5)	8 (38)	0 (0)	20 (92)
D High on Environmental Scale (2-4)	6 (10)	30 (11)	30 (144)	62 (35)	20 (88)
E Very Concerned About Water Pollution	30 (42)	43 (40)	41 (196)	65 (34)	38 (168)
F Use Water for Recreation	34 (62)	62 (25)	71 (334)	83 (43)	49 (220)

[1] "Low" amounts are defined as any amount equal to or lower than half the amount people of the respondents' income category were said to spend on space. "High" are amounts equal to or greater than the education amount given on the payment card. "Normal" are all amounts in between the low and high amounts.

[2] Total N varies for each of the demographic and attitudinal categories.

[3] Definitions of variables arc as follows: high income = 25t + / low education = high school or below/ high on environmental scale = score of 2-5 on a scale constructed from seven questions which varies From -5 to +5 ; See Appendix ___ for a Full description of the scale / water user = someone who has fished, boated or swam in last two years.

[4] Note that these percents are each independent of the rows and colums. Here, 13 percent of those who are willing to pay $0 have a "high" income.

($25,000 and above), and a lower percentage of users of freshwater for recreation. Overall, they are as environmentally concerned as the normals but are older, wealthier and somewhat less likely to use water for recreation. This combination of characteristics does not suggest upward-biased strategic behavior, although it is not inconsistent with free riding.

The highs are also higher in income than the normals. They are much more likely to be high on our environmental scale -- and in their concern about water pollution as a problem -- and somewhat higher in recreational water use (See Chapter 5 for a description of these measures). Although we would expect those who use and value water to place a higher value on it through their willingness to pay, and while half of the highs are in the highest income category and presumably can afford the amounts they said they are willing to pay, these data are consistent with the idea that some of these 52 people are overestimating their real willingness to pay. Whether this is the result of deliberate calculation (strategic bias) or unrealistic enthusiasm (hypothetical bias) cannot be determined. We do know they are more than balanced by the 183 zero bidders.

Hypothetic Bias

Hypothetic bias is the "potential error induced by not confronting the individual with the actual situation" (Schulze, et al., 1980). In a situation influenced by hypothetic bias people are so far removed from the actual situation that they do not have "genuine" opinions. Perhaps they are being asked about something which is so far removed from their experience and interests that they are indifferent to the public good. Alternatively, they may have sufficient interest or potential interest in the topic but the subject of inquiry is not specified in sufficient relevant detail in the instrument for them to have anything but superficial opinions. This is why social surveys sometimes find opinions about controversial topics shift dramatically according to the way contingencies associated with the issue are spelled out or specified.For example, attitudes towards nuclear power can be made to shift by 40 percentage points by varying the degree of assurance about nuclear safety in the working of the question (Mitchell. 1980:12).

Hypothetic bias may produce a variety of effects. One is greater uncertainty and ambivalence on the part of the repsondent compared with his or her response to a "more realistic" situation. The empirical consequence of this is increased variability in responses and/or a larger than normal number of refusals and don't knows. This uncertainty and ambivalence means that a respondent's WTP amounts are much more susceptible to the pressures of social desirability. In many cases (especially those involving substantial amounts) the direction of social desirability will be ambiguous or nonexistent. Below we explore the direction of hypothetic bias for this case.

The other primary effect is the rejection of some aspect of the hypothetical market in WTP surveys, The payment vehicle is usually the cause of this rejection which takes the form of refusals or protest zero amounts. This effect is more properly a separate component of the larger context correspondence problem we discuss later. Since this response is not due to availability to visualize the market.

Since WTP studies are by definition hypothetical, the avoidence of hypothetic bias requires ingenuity on the part of the researcher. It is the burden of our argument in this section that hypothetical or contingent markets can be described in such a way as to minimize hypothetic bias. We first discuss two preliminary topics which have not been much discussed in the literature: the direction of hypothetic bias and the relationship between strategic and hypothetic bias. We then treat the question of whether and under what circumstances survey research can realistically simulate markets for public goods, In the final part of this section we consider the extent to which our instrument suffers from context correspondence problems.

The Direction of the Bias

The WTP literature habitually refers to hypothetic "bias," but does not show what bias or systematic distortion of the WTP amounts is to be expected from unrealistic research instruments. Where people lack "genuine" opinions about a particular issue we would expect their responses to be more random than would be the case for an issue on which they held genuine opinions. In the former, more people will "guess" rather than "estimate." Such guesses are vulnerable to extraneous matters such as fatigue, personal attraction to the interviewer, exposure to the evening's news on television, etc. For this reason, WTP amounts affected by hypothetic bias will show greater statistical variance and less reliability than those not so affected. Combined with the constrained nature of WTP distributions, this greater variance will bias the WTP amounts upwards.

Let us consider this argument in greater detail. Given an initial (in our case the true) probability distribution with a known mean and variance, increasing the variance of that distribution may necessarily result in an increase in the mean (or expected) value of that probability function. This increase in E(x) can be shown to hold for many common probability distributions (the common characteristics of which appear to be a constraint on the ranges of values which the function can take). This constraint may be definitional or artificially imposed; in our case this constraint is the impossibility of negative values.[5a] Two probability

[5a] It should be noted that protest zeros must be removed before the distributional phenomenon described here can be observed.

distributions have been proposed for WTP distributions of our type: log-normal (Gramlich, 1977) and normal (Brookshire, et al., 1976).[6]

The log-normal distribution can be defined for x as $x = \exp(y)$ where $y = N(u,\sigma^2)$. The expected value of x is $E(x) = \exp(\mu + (1/2)\sigma^2)$ and the variance of x is $VAR(x) = \exp(2\mu + \sigma^2)(e^{\sigma 2} - 1)$. It can be straightforwardly observed that an increase in VAR(x) causes an increase in E(x).

The normal distribution is the other distribution which has been suggested as the appropriate distribution for WTP amounts. Because the mean and variance are independent from each other in the normal distribution, increasing the variance of the probability distribution does not change the mean. However in the case of WTP distributions we are not dealing with a true normal distribution, but a normal distribution which is artificially constrained[6a] to be non-negative. We shall call this distribution a constrained normal. Through a series of heuristic graphs we will show why the mean WTP value increases for this distribution when the variance of the initial probability distribution is increased.

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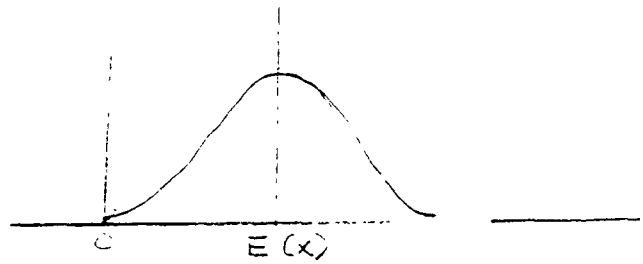
[6] The increase in the E(x) for an increase in the variance of the original chi square or F distribution follows directly from the inter-dependence of the mean and variance of a chi square or F variable. See Hogg & Craig (1978) or Freund and Walpole (1980) for a detailed discussion

[6a] In theory, nothing prevents a legitimate negative bid. Two examples of rational negative bids would be a person who feared clean water would bring hordes of tourists to his or her doorstep or the person who disliked environmentalists so much that the pleasure which clean water brought environmentalists caused him displeasure. In practice, however, no governmental authority would pay a citizen in order to provide him with clean water. We believe that the number of consumers whose true value for water quality is negative is sufficiently small so that we may consider the constraint of non-negative values to be inoperable. This is not necessarily true where the nature of hypothetical markets encourages a large increase in σ^2 relative to the true distribution.

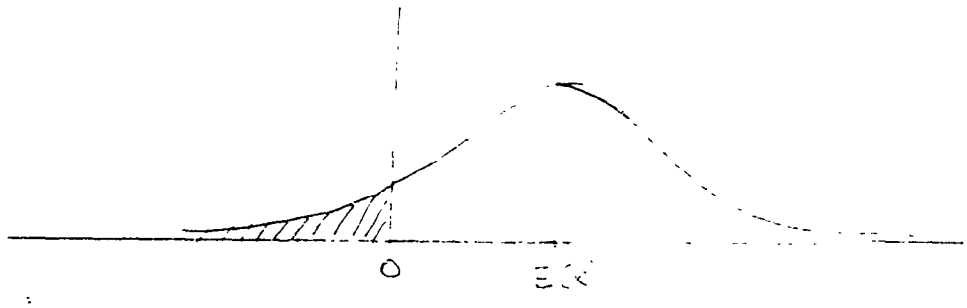
First consider the following graph of a true probability distribution:

Figure A



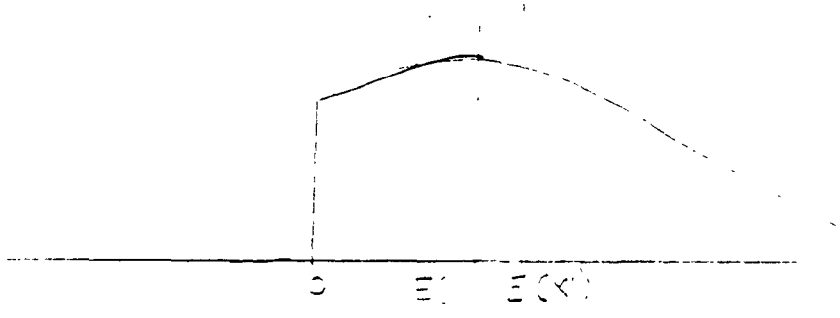
In Figure B below, we increase the variance of the original distribution. The mean of the new distribution is the same as the original and is indicated as E(x). The area shaded in to the left of zero is the area which will be truncated if the constraint is operable.

Figure B



Now suppose that the distribution is constrained at zero so that if $x < 0$ then $x = 0$. The truncated area of Figure 2 is rotated upward to the right side of the zero axis and the resulting distribution is shown in Figure C. In this Figure E(x) is the expected value of the original distribution and E(x') is the expected value of the constrained normal distribution. In terms of the definition of the sample mean of a normal variable? = $(\Sigma x_i/n)$ some of the x_i's are greater than they would have been in the unconstrained distribution causing $\bar{X}' > \bar{X}$.[7]

Figure C



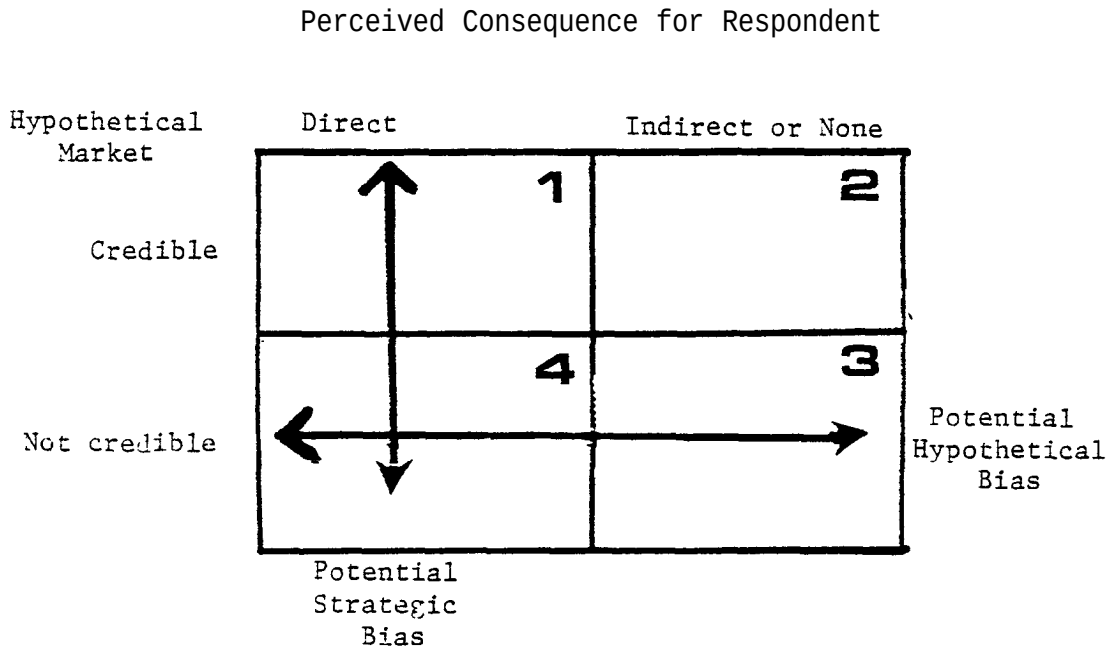
[7] In a more severe case than our constrained normal distribution -- that of a truncated normal distribution where the truncated observations are discarded -- Cohen (1950, 1967) has shown that the sample mean of the resulting distribution is dependent upon the variance. As an example, if a normal distribution with mean zero and variance σ^2 is truncated at zero and all negative observations are discarded the resulting sample mean is $\bar{X}' = \sqrt{\frac{2}{\pi}}$ which must be greater than zero unless $\sigma = 0$.

The Relationship Between Strategic and Hypothetical Bias

A second important aspect of hypothetical bias which is unresolved in the literature is the nature of its relationship with strategic bias. When statements are made that: "The hypothetical nature of such (WTP) surveys may then, in actuality, aid in eliciting bids which are not strategically biased" (Schulze, et al., 1980:11) the implication is that hypothetical bias is the opposite of strategic bias. According to this logic,strategic bias occurs because people believe the situation is "real" and cover up their "genuine" opinions to suit their perceived interests whereas it is the unreality of the situation which promotes hypothetical bias. We believe it is more correct to distinguish strategic from hypothetical bias in terms of the types of realism involved, however. Strategic bias is promoted when the consequences of the WTP questions are perceived by the respondent as real. Hypothetical bias, in contrast, is induced when the market described to the respondent is not realistic enough. These two factors may vary independently as shown in Table 4.3. Respondents may perceive that they either will have to pay the amount they state for

(continue)

Table 4.3 TYPES OF REALISM AND STRATEGIC AND HYPOTHETIC BIAS



the public good or that their responses will directly influence public policy. On the table this is described as a direct consequence and promotes strategic bias. Alternatively this consequence may not seem likely to them, a perception which appears to be the general rule among respondents in WTP studies including this one. Turning to the other dimension, hypothetic bias is minimized when the hypothetical market is credible or plausible to respondents in that it accords sufficiently with their understanding of how the world works and imposes realistic (albeit hypothetical) constraints on preferences (by introducing cost, for example). It is the absence of this market realism which promotes hypothetical bias. Both biases are minimized, therefore, when consequence realism is low and market realism is high (cell 2 in the Table 4.3).

Schulze, et al., in a discussion of hypothetic bias argue that both consequence and market realism are necessary for WTP surveys (cell 1):

> "The contingent valuation approach requires postulating a change in environmental attributes such that it is believable to the individual and accurately depicts a potential change. The change must be fully understandable to him, i.e., he must be able to understand most, if not all, of its ramifications. The individual also must believe that the change might occur and that his contingent valuation or behavioral changes will affect both the possibility and magnitude of change in the environmental attribute or quality. If these conditions are not fulfilled, the hypothetical nature of contingent valuation approaches will make their application utterly useless." (Schulze, et al,, 1980:14).

We agree with the first part of their statement, but not the second part. We do not believe, as they apparently do, that consequence realism is necessary for a credible survey. Certainly none of the WTP surveys reported in the literature on air and water pollution have achieved it, a judgment in which Schulze and his colleagues concur; and if they had, strategic bias would become a genuine problem for WTP surveys. In what follows we argue that properly designed surveys can describe situations with sufficient realism to elicit meaningful responses and discuss the adequacy of our questionnaire in this regard. We then propose theoretically based regression estimations as an appropriate test for hypothetical bias.

Survey Research and Market Simulation

According to Randall, et al. (1974:135) the validity of WTP surveys "depends on the reliability with which stated hypothetical behavior is converted to action, should the hypothetical situation posted in the game arise in actuality." The challenge is to create a believable and meaningful set of questions which will simulate a market for the public good in question, Some would argue that this is an impossible task, that survey research is too removed from reality to be able to predict behavior. This view seems to lie behind the remarks of Gary Fromm that "It is well known that surveys that ask hypothetical questions rarely enjoy accurate responses" (Fromm, :172).

In fact, as Howard Schuman and Michael Johnson (1976) show in their major literature review of the relationship between attitudes and behavior, most studies which measure people's attitudes and their subsequent behavior show positive results. At the individual level, for example, those Army trainees who say they are eager for combat are significantly more likely to perform well in combat several months later (Stouffer, et al., 1949) and persons who say they support open housing are far more likely (70%) to sign an open housing petition three months later than those who expressed opposition to open housing (22%) (Brannon, et al., 1973). One study of four elections showed behavioral intention predicted correctly to actual vote for 83 percent of the respondents who voted (Kelley and Mirer, 1974). Schuman and Johnson cite numerous other examples of attitude behavior correlations and conclude that the attitude-subsequent behavior correlations which occur "are large enough to indicate that important causal forces are involved" (Schuman and Johnson, 1976:199) although the variance explained by attitudinal intention is usually fairly modest.

The most impressive demonstrations of attitude-behavior correlations occur at the aggregate level. Modern election polls predict election results with great accuracy. The 1980 presidential election was no exception to this generalization because the polls which took place immediately before the vote caught the last minute shift which brought President Reagan to power (Ladd and Ferree, 1981). For many years the Institute for Social Research at the University of Michigan has used

survey research to measure consumer sentiments and probe the psychology of economic behavior. Their Index of Consumer Sentiment represents a macro measure reflect&g the changes in attitudes and expectations of all Americans. For the past 25 years it has declined substantially prior to the onset of every recession and it advanced prior to the beginnings of periods of economic recovery (Katona with Morgan, 1980). These correlations occur despite the fact that the University of Michigan economists are unable to predict an individual's spending or saving on the basis of changes in his or her attitudes and expectations. They attribute this paradox to fact that individual consumer behavior is influenced by a large number of factors including situational, attitudinal, and physical (fatigue) which make accurate predictions of individual behavior difficult to make. The volatility of individual behavior is smoothed out for aggregations of people; mood, individual differences in how people react to the particular stage in the business cycle, individual reactions to whether or not they have recently purchased large consumer durables and the like are averaged across the sample (Katona with Morgan, 1980:60). This is a strong argument for the validity of surveys (provided the questions are well worded and the sampling is adequate) as measures of aggregate benefits.

We conclude that properly designed survey questions do have the potential to ap proximate real situations sufficiently to elicit "responsible" responses which can be predictive of behavior under the defined circumstances contained in the questions (Brookshire, et al., 1979:30-31). Schuman and Johnson analyze the design factors which improve behavioral predictions, One of the most important is the degree of congruence between the expressed attitude and behavior. Heberlein and Black (1976), for example, found

(continue)

attitude-behavior correlations increased from .12 to .59 for the use of lead-free gasoline when the predictive attitudes shifted from general interest in environmental issues to a question about the degree of personal obligation the respondent felt to buy lead-free gasoline. In a similar vein, Brookshire, d'Arge and Schulze cite the psychologists' Ajzen and Fishbein's well known dictum that behavioral intention and the actual behavior "should correspond, in terms of the action, its context, its target and its time frame" (Brookshire, et al., 1979:25).

A second important design factor is the degree of information presented about the consequences of an attitude, particularly its financial implications. The more fully these consequences are specified, the more realistic the response. In the 1960s Gallup consistently found a majority of people favored foreign aid when they were asked: "In general, how do you feel about foreign aid -- are you for it, or against it?" In a national survey during the same time period, Lloyd Free and Hadley Cantril introduced the pocketbook aspect of the issue in a question which asked whether "government spending for this purpose (foreign aid) should be kept at least at the present level, or reduced, or ended altogether?" When costs were raised in this manner the majority position shifted from favoring foreign aid to wanting it reduced or ended (Free and Cantril,1967:72;/ see also Mueller, 1963). A similar shift occurred in a poll conducted in the Swedish city of Malmö. In this case a sample was asked whether they would like the Swedish government to increase aid to less-developed nations. Later, in the same questionnaire, the respondents were asked whether they would like this to take place "even if taxes would be raised in proportion." Half the supporters of increased aid vanished when the question was phrased this way, leaving only 20 percent who were willing to pay for increased aid (Bohm, 1979:146).

The shifts in opinion evoked by the changes in question wording are understandable because we would expect higher demand for free goods according to economic theory, The Swedes who favor foreign aid in the first question consist of two types of people: 1) those who favor it in the abstract but who are not willing to pay for it when reminded of that contingency and 2) those who favor it in the abstract and who are also willing to pay for it, The second question induces those in category 2) above to relinquish their support by introducing the contingency of cost. WTP studies go one step further, of course, and ask respondents to specify the amount of money they personally are willing to pay, This and the fact that many other contingencies are spelled out in the questionnaire makes them a far more realistic measure of attitudes than ordinary survey research items.

Context Correspondence

As we noted in Chapter 2, there are special challenges in devising a macro WTP instrument which is sufficiently realistic to avoid hypothetical bias, We made special efforts, as described in Chapter 3, to present the market for national water quality in terms that are understandable to the respondent and which related as closely as possible to the way the respondent actually contributes to the provision of water quality. We will not repeat that discussion here, but will amplify it by discussing the degree to which our instrument is threatened by context correspondence problems, a particular form of hypothetic bias.[7]

As described by Brookshire, et al. (1979, 26ff), these problems occur "where the initial rights and endowments as well as the terminal rights and endowments are far removed from the actual situation." The primary example of the context correspondence problem is the failure of questions using the willingness to accept compensation format to elicit meaningful answers. The notion of being "bribed" to tolerate pollution is so far out of people's ordinary comprehension that many people apparently consider it immoral and refuse to value the environmental good at anything less than infinity (Randall, et al., 1974; Blank, et al., 1977: Brookshire, et. al., 1980 and above in Chapter 1). Is is possible that the high percent of no-plays and zero bidders we found is an indicator that our instrument suffers from context correspondence problems?

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[7] Brookshire, et al., say a high percentage of protest votes is an indicator of context correspondence problems (1979:28)

On an a priori basis we do not believe this to be the case. The initial endowment of boatable water nationally and the notion that people are paying for water quality of this level in taxes and higher prices seems well within people's understanding, particularly since they are already paying for water quality in this manner (although they may not have thought about it), Our instrument assumes a structure of rights in which fresh water is a common property resource which can be used for various purposes, The simulated market provides a situation in which the individual can buy improved water quality situations by paying higher taxes and prices.[8] It assumes that these cannot be provided free of charge. It is possible that some people may feel that businesses should pay the costs of treating pollution out of profits instead of passing the costs on to consumers, but surveys suggest that a large majority of the public are aware of the fact that these costs do get passed on to consumers (Cambridge Reports, 1978:167).[9] Finally, the improved situations we propose, fishable and swimmable water, do not appear to be so far from the initial position (boatable water nationally) to cause problems nor to deviate dramatically from the person's previous experience and preferences. Most people will have had first hand contact with freshwater of those quality levels.

However, when we ask people to put a dollar value on water quality levels we are asking them to do something that is not part of their normal

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[8] In the case of going from boatable to non-boatable the respondents were buying the continuance of the status quo. See the more detailed discussion of property rights in Chapter 1 where we specify the types of consumer surplus measures we employ in this study.

[9] Cambridge Reports in a report for the Shell Oil Company asked a national sample: "When the government imposes new health or safety standards on an industry which single group do you think usually pays the cost of implementing those standards: the industry out of its profits, workers in the industry through lower wages, consumers through higher prices or the government using tax money? Sixty-two percent said consumers through higher prices (Cambridge Reports 1978:167) and 12 percent "the government using tax money." Only 7%

behavioral repertoire; both the valuing and the contemplation of national water quality are novel experiences for most people, By way of contrast, those WTP studies which ask people to place a value on certain characteristics of a particular recreational site in terms of an entrance fee ask people to perform a much less novel act since people are familiar with entrance fees and regularly make decisions about whether or not they are worth the price. Does this mean that such a study is necessarily more valid than ours? We think not,because familiarity may present problems of its own. When respondents are asked to express WTP amounts by the entrance fee vehicle (e.g. Thayer, forthcoming) the amount they give may represent not what they personally consider the benefit to be worth but what they consider to be a "fair" entrance fee based on their experience with entrance fees, Thus, novelty as such need not be an impediment. What matters most is whether respondents are made sufficiently familiar with the new situation in the interview.

Where context correspondence is present we will expect two outcomes. The first is a greater incidence of item nonresponse for the WTP items. More people will be unable to find the situation meaningful enough to offer WTP amounts or in protest they will bid $0. WTP surveys test for context correspondence by examining (and reporting) the rates of these responses. As noted earlier we had large numbers of people who failed to give amounts or who gave $0 amounts. In our discussion of this problem below, under item nonresponse bias, we conclude that it is probably caused by problems other than context correspondence.

Secondly, if the situation which respondents are valuing is too removed from the experience or interests, their answers to the WTP questions will be more whimsical than purposeful and should vary randomly. Conversely, if the task is meaningful to the respondent, his or her answers will be constrained by the factors which influence decisions about such expenditures in everyday life: income and value. The context correspondence problem in this instance is increased/ variability. An appropriate test for randomness of responses is the size of R^2 in a regression of WTP amount on theoretically-based constraints[10] (in our case: recreational use of freshwater, concern about water pollution, income, etc.). We report the results of our predictive test in Chapter 5. Our findings in this respect are very reassuring.

INSTRUMENT BIASES

The willingness to pay literature has identified four instrument characteristics which are potential sources of bias, These are the payment vehicle, information, order and starting- point biases. A number of studies have varied these dimensions systematically in an effort to see whether or not a particular instrument bias is present. Our effort in this regard was limited to the most innovative aspect of our instrument; the use of the payment card to elicit the respondents WTP amount. The results of this experiment are discussed in detail under starting point bias. The instrument was designed to minimize the effect of each of the other potential biases.

Starting Point Bias

In Chapter 3 we discuss why we believe starting point bias is a serious problem for bidding game studies which use payment vehicles other

[10] For an excellent example, see Brookshire, et al., 1980.

than admission fees to measure people's willingness to pay for public goods. We developed the anchored payment card as a substitute for the opening bid on the assumption that presentation of a large menu of potential bids would minimize any tendency on the respondent's part to acquiescece to the interviewer's suggested bid. There is the possibility of course, that the payment card itself might bias the WTP amounts. To examine this possibility we manipulated the two aspects of our payment cards which seemed to present the greatest possibility of influencing respondent WTP amounts and tested several different versions of the payment card on comparable sub-samples. These variations and the rationale behind them are as follows:

1. The payment card is anchored with estimates for non-environmental goods. We varied the number of goods presented from four in versions A and C to five in Version B.[11] The extra good in Version B was police and fire protection, The amount which we estimated households spent on this good ($98, $125, $312 and $626 for the four income levels[12]) was such that it placed police and fire protection on the payment card at a place where we guessed people might value water quality. Except for the addition of the fifth

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[11] In this discussion we will only consider versions A, B, C, of our instrument. Version D was significantly different and our findings for this version will be described elsewhere. See Chapter 3 for a description of the research instrument and Appendix I for the complete wording of all the questions.

[12] See Appendix III for the procedures used to derive the public good expenditures and Appendix I for all the payment cards used in the study.

public good, the payment cards for Version B are identical to those for Version A. If the number or placement of the anchors affects the starting point we would expect the mean WTP amounts for B to differ from the amounts for the other versions.

2. In order to see whether people keyed their water benefit amounts to the amounts shown on their card for the other public goods, Version C displayed the same four public goods as Version A, but each amount was increased by 25 percent. If the dollar level of the anchor or benchmark goods determines the WTP amounts for water quality we would expect higher mean amounts for Version C than for Version A.

Table 4.4 summarizes the sample design for our tests of starting point bias. We used t tests to test for the hypotheses:

Test I H_o: $A = C$

H_1: $A < C$

Test II H_o: $A = B = C$

H_1: $A \neq B, A \neq C, B \neq C$

Where A, B, C refers to versions A, B, C.

Table 4.4

STUDY DESIGN FOR EPA WATER POLLUTION BENEFITS STUDY
AND NUMBER OF CASES (IN PARENTHESIS)

	Versions	*Family Income Levels*	*Water Quality Levels*
			Amount willing to pay for:
A	Scale cards with the estimated levels of payment for space, highways, public education and defense for each of the four income categories. (431)*	I $9,999 or less (117) II $10,000 to 14,999 (58) III $15,000 to 24,999 (112) IV $25,000 and above or not sure/refused (92)	D Okay for boating (2.5 on 10 step ladder) C Game fish like bass can live in it (5.0) B Safe for swimming (7.0)
B	Scale cards with correct payment levels for the four public goods used for A plus police and fire (380)	Same as A I (170) II (66) III (98) IV (62)	Same as A
C	Scale cards with same four public goods used for A but the payment levels listed are 25% higher than those used for Version A (410)	Same as A I (116) II (58) III (126) IV (74)	Same as A
D	Same as A plus the estimated amount for water pollution control (355)	Same as A I (82) II (78) III (103) IV (70)	Asked whether willing to pay the specific amount for level C If not willing to pay, asked how much willing to keep level at D If willing to pay for C, asked how much willing to pay for B

"The total number of cases for each version exceeds the sum of the number of cases ascribed to each income level for that version owing to the absence of income data for some respondents.

The results of these tests for each income by water quality level category are given in Table 4.5. Of the 24 paired comparisons only two are significantly different from zero (less than the number positive findings one would expect by chance at the .05 level) and both are in the opposite direction to that predicted if starting point bias is present. We conclude that for I and II, the null hypothesis is supported: there is no evidence of starting point bias.

A second test of starting point bias was conducted using regression analysis. We made dummy variables for each of the three versions. We then estimated two sets of equations for pairs of versions. The first used one of the dummy variables as the sole predictor variable, the second is identical to the first except that we added the set of predictor variables which are the best predictors of the WTP amounts. If H_o in Test II is incorrect, the dummy variables for the versions should enter the equations significantly (as measured by the t values). Table 4.6 presents the results of these estimations. None of the version dummy variables are significant, confirming our finding above that our instrument does not suffer from starting point bias.

On the basis of these findings, which not only show no version effect but also reveal an impressive stability across the versions in the multivariate estimations, we combine the three versions into one data set for all further analysis.

Table 4.5 t TESTS OF MEANS[1] FOR PAIRED COMPARISONS BETWEEN VERSIONS A, B, C BY INCOME AND LEVEL OF WATER QUALITY

		Level of Water Quality								
		Boatable			*Fishable*			*Swimmable*		
Income Level										
Low	1	AB	AC	BC	AB	AC	BC	AS	AC	BC
	2	AB	AC	BC	AB	AC*	BC	AB	AC	BC
	3	AB	AC	BC	AB	AC	BC	AB	AC	BC
High	4	AB	AC	BC	AB	AC	BC	AB	AC	BC

[1] Two tailed test, variances between samples were compared and then the t test was computed on pooled or separate variables as appropriate.

The one tailed t-test was insignificant for every pair of A and C for test I since the two significant pairs of A and C (* in the table) under the two tailed t tests are in the opposite direction from that predicted by H_1 of test I.

*Difference between the means is significantly different from 0 at the 5% level.

Table 4.6

TEST FOR STARTING POINT BIAS

Variables

Level C	Amount willing to pay annually for fishable water in dollars
VERA	Dummy variable for Version A
VERB	Dummy variable for Version B
VERC	Dummy variable for Version C
INCOMER	Household income in dollars in 10 categories
EDUC	Education in 7 categories
AGECAT	Age in 11 categories
ENVINDEX	Index of environmental attitudes*
USERD	Dummy variable for water use
CNPOLD	Dummy variable for concern over water pollution

Regressions on Level C for Versions A, B, C as Noted:

	A & B	A & C	B & C
Intercept	179.44 (10.7)	190.6 (10.8)	190.6 (11.5)
VERA	32.4 (1.4)	21.4 (.9)	
VERB			11.1 (-.5)
N	515	500	481
R^2	.003	.002	.001
F	1.9	.79	.24
Intercept	-30.4 (-0.60)	-8.2 (-.15)	-21.4 (-.44)
INCOMER	.0072 (8.95)	.0069 (8.4)	.0073 (9.3)
EDUC	16.8 (1.85)	13.9 (1.4)	15.1 (1.78)
AGECAT	-10.5 (-2.88)	-8.7 (-2.3)	-8.4 (-2.5)
ENVINDEX	26.06 (3.81)	29.8 (4.3)	30.9 (5.2)
USERD	54.41 (2.33)	40.9 (1.74)	27.46 (1.3)
CNPOLD	44.47 (1.95)	48.3 (2.1)	64.8 (3.2)
VERA	21.58 (1.03)	12.22 (.58)	
VERB			-12.7 (-.67)
N	472	467	451
R^2	.30	.29	.34
F	37.9	27.3	32.4

t values are given in parenthesis

*Composed of 7 items ranging from attitudes towards the environmental movement to the importance of environmental problems in the respondents hierarchy of issues.

Payment Vehicle Bias

In Chapter 3 we describe why we chose annual household payment in higher prices and taxes for our payment vehicle. There we argue: 1) that our vehicle realistically accords with the actual form of payment for water quality and 2) that it is familiar to respondents yet lacks the drawbacks posed by some familiar vehicles such as entrance fees which may limit WTP responses to an accustomed payment range rather than to a true WTP amount. A further criteria for payment vehicles imposed by economic theory is that they should offer respondents the widest possible latitude of potential substitution across current commodities (Schulze, et al., 1980:12). We believe our vehicle combines believability with the widest latitude for substitution, two characteristics which often must be traded off in WTP surveys (Brookshire, et al., 1979:23-4). In the administration of the survey we encountered no problems with the vehicle. If the vehicle suffers from any bias it is likely to be downward owing to the current national concern over taxes and prices.

Information Bias

Information bias occurs when the wording of the instrument affects the values elicited in ways unintended by the researcher. The result is the introduction of contingencies other than those contained in the formal hypothetical situation. Because the opportunities for information bias in questions are legion, the evaluation of a WTP study must include a review of the wording of the entire instrument and an examination of the quesiton. In Chapter 3 we introduce and describe the questions we

used in this study. Needless to say, we attempted to word the instrument in such a way that by spelling out the tradeoffs, the cost, the fact that they are already paying for public goods, etc. the respondents were presented with a credible hypothetical market for water value. We endeavored to word the instrument in as neutral a manner as possible so that neither the costs nor the benefits of water quality were emphasized at the expense of the other. Readers can judge the success of our efforts for themselves by consulting Appendix I which contains the entire instrument in the form it was given to the interviewers.

Order Bias

Order bias is closely related to information bias. Some information may influence people's responses in an unwelcome manner simply because of its location in the questionnaire. The little research that has been done on order effects suggests that this is not an important source of bias in surveys (Alwin, 1977:141), but good survey practice dictates that sensitive or potentially biasing items should be located later in a questionnaire, otherwise the sensitive items might lead respondents to prematurely terminate the interview and the biasing items might affect the answers to questions which are sensitive to that type of bias. In WTP surveys it is important to avoid preceding the WTP items with questions which emphasize the benefits of the good being valued at the expense of the cost or vice versa. Rowe, et al. (1979:6) specifically cite the possible influences of early environmental attitude questions in this regard.

The RFF water benefits was preceded by a half hour (or more) interview on environmental and energy issues. The questionnaire for this study is contained-in Appendix IV. What bias, if any might result from the respondent being subjected to a searching interview about environmental protection, environmental values, risk, energy source preferences, and government action on these matters? Yore particularly, might these questions stimulate a greater value for environmental quality than would otherwise have been the case and bias the WTP amount upwards? We think this is unlikely for the following reasons:

1. The earlier questions were realistic and balanced because they measured environmental values in the context of the tradeoffs associated with obtaining better environmental quality. They a) forced people to rank order environmental goals with other goals (Qs. 1-10), b) elicited people's views about economic and energy problems (Qs. 11a, b, f; 21a, f; 26; 40-46) and c) used questions whenever possible which described the tradeoffs entailed in minimizing risk or protecting the environment (e.g., Qs. 31, 34-36, 39, 53c).
2. A contributing factor to the realism of the RFF environmental survey is the unique historical context of the survey. Most of the interviewing occurred in late January and early February 1980, a time when the Iranian hostage crisis and the Russian invasion of Afghanistan were dominating the news. These concerns, added to the great concern expressed by our respondents about

inflation and higher prices, suggest the historical context did not bias the respondents towards taking an environmentally oriented position. If anything, the opposite is likely to be the case.

3. It is possible to compare the degree of environmental support revealed in the RFF questionnaire with the findings of a commercial phone survey (Opinion Research Corporation, 1980) which took place two months after most of the RFF interviewing and which repeated several key questions word for word. The commercial survey found even stronger support for environmental values than did the RFF survey. This suggests that the format of the RFF survey did not bias people towards viewing the environment with special favor, but rather it seems to have led people to evaluate the issues with greater realism.

In our judgment the earlier environmental/energy questions add to the validity of the WTP study by requiring the respondents to consider a wide range of environmental issues and their tradeoffs prior to evaluating the worth of water quality. It is possible, however, that the length of the first portion of the survey may have induced respondent and interviewer fatigue. If we had used the bidding game format fatigue, if present, might have biased the WTP results upwards by tempting respondents to acquiesce to the starting point more often than would otherwise have been the case. (or downwards by making their willingness to pay bid lower). Since the payment card technique minimizes starting point bias, we have no reason to believe that fatigue biased our results upwards in this manner. On the contrary, fatigue may be a cause of the large number of zero amounts and no answers which we experienced.

SAMPLING BIASES

There is a set of potential biases associated with the methodology of survey research which have received less emphasis in the WTP literature than they should. An instrument may be entirely free from general and instrument biases, but if it suffers from serious sample and non-response problems its findings cannot be generalized reliably to a larger population of any kind and should not be used to estimate aggregate benefits. In the past some WTP studies have made such aggregate benefit estimates on the basis of seriously flawed samples or, worse, without even reporting the information necesary to assess whether method biases are present or not.

Sample Bias

Scientific sampling is a process by which elements of a population are chosen in such a way that information about those elements can be generalized within known error ranges to the population from which the elements are drawn. Methods of sampling are well grounded in statistical and probability theory. There are numerous sampling techniques but the distinguishing characteristics of a properly designed sample are that all the units in the target population have a known, nonzero chance of being included in the sample, and the sample design is described in sufficient detail to permit reasonably accurate calculation of sampling errors.[13] Sampling bias occurs when samples are not properly designed or reported.

[13] For a presentation of sampling theory and design for the non-technical reader see Williams (1978). For a discussion of sampling for surveys see Babbie (1973:73-130) and, especially Sudman's excellent book, Applied Sampling (1976).

The sampling method used for the RFF survey is a probability sample, the more rigorous of the two sampling methods regularly used by commercial survey research firms (the other being the modified probability sample). A description of the sample, which was designed by the Roper Organization, is presented in Appendix V. It ensures that all noninstitutionalized persons, 18 years of age or older, who live in the lower 48 states have a known probability of being interviewed.

There are many considerations which enter into the decision about how many people to interview for a study,but the basic tradeoff is between cost and accuracy, Presuming that the respondents are selected according to sampling theory, the smaller the size of a set of respondents (which may range from the entire sample to a sub-sample of special interest to the analyst such as environmental activists), the larger the sampling error. For a simple random sample, the error range at the .05 level of confidence is 3 percent for 1,067 respondents and 7 percent for 196 (Backstrom and Hursh, 1963:33). For a sample of 50, the Opinion Research Corporation estimates a 14% sampling error. Thus, if 25 percent of a sample of 50 say they went boating at least once in the past two years, the true value will lie between 11 and 39 percent, 95 percent of the time. Obviously, if these 50 people were not chosen by proper sampling techniques the error range is unknown,and it is impossible to say anything about what percent of any larger population (such as the people who live in the area where the interviewing took place) went boating in the last two years. For this reason, a true[14] sample of 1500 people allows Gallup to predict

[14] We use "true" here to refer to a probability based sample,

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to of the to be interviewed or are
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interviewer calls. is
interviewed are likely to differ
in systematic ways. For example, they may be more
or less environmentally of what constitutes a
significant number does not have a simple answer owing to variations in
(some call for substitutions on a prespecified
the is not available at the the interview), in
interview method (rates differ telephone,
techniques), method of calculating the response rate (since
non-responses can to to not being to
terminating the interview before it is completed, etc. the way of calculating
the to what is defined as a non-response) (Dillman,
1978:49-52).

When there are no established criteria for determining the quality of the response rate, as is the case for most surveys which are not conducted by professional survey research organizations, researchers should provide sufficient information to enable the reader to evaluate the sampling implementation.[15] In our case, we used a professional organization and well established sampling procedures. The response rate for our survey is 73 percent, computed upon the number of interviews completed in households containing people eligible for an interview. Those not interviewed included people who refused and those who were not at home even after the interviewers made up to three call backs to reach the person in the household designated to be interviewed by the sampling plan. This response rate is well within current national sample survey practice using this methodology.[16] A comparison between the RFF sample and census data for age, education, income, sex, race and region shows the RFF sample to be a close approximation of the nation on all but education and those with the highest income (Table 4.7). Those with a less than high school education and the highest income are somewhat under represented , a common occurrence in sample surveys as these people are among those most likely to unavailable (the rich travel or are less accessible; those with low educations are disproportionately

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[15] The Colorado State researchers, for example, describe their samples in admirable detail (Walsh, et al., 1978:19-23) and include a table which informs the reader that of 600 people originally selected for interview, 48 letters were returned, 231 could not be contacted by phone, 119 refused to be interviewed when contacted and 202 were interviewed.

[16] Although it is impossible to make a direct comparison, our 73 percent may be compared to the 37% rate achieved by the Colorado State researchers (excluding the returned letters, but including in the base those the interviewers could not reach and those who refused?.

Table 4.7

DISTRIBUTING OF RESOURCES FOR THE FUTURE SURVEY
ON KEY DEMOGRAPHIC VARIABLES

	RFF	Census*
Age		
18 - 24	16%	18%
25 - 34	26	22
35 - 44	15	16
45 - 54	14	15
55 - 64	15	13
65 +	15	I.6
	100	100
Education		
	(age 18+)	(age 25+)
Less than High school	25	32
High School	38	37
some college	20	1.5
college	17	16
	100	100
Income		
Under $9,999	25	24
$10 - 14,999	16	17
15 - 24,999	28	31
25 +	22	28
refused	10	-
	1.01	100

	RFF	Census
Sex		
Male	47%	48.7%
Female	53	51.3
	100	100.0
Race		
Black	12	12
White	87	88
	99	100
Region		
New England	7	6
Mid Atlantic	17	17
East North Central	17	19
West North Central	9	8
South Atlantic	17	16
East South Central	6	6
West South Central	9	10
Mountain	5	5
Pacific	14	14
	101	101

*Current Population Reports (Population characteristics: Profile or the United States: 1979) Series P-20, No. 350, U.S. Department of Commerce, Bureau of the Census, May 1980.

among the very old). Other factors may play a role here too, The 10 percent who refused to reveal their incomes may be disproportionately well off. The census data are not from the 1980 census (which was unavailable when the table was constructed) which presumably will show a higher percent of people with college educations than the earlier census estimates.

INTERVIEW BIASES

Item Nonresponse Bias

Respondents invariably fail to answer at least one question in an interview. This presents a problem when the analyst wishes to generalize from a sample to a population. Item nonresponse bias is the distortion in the estimate of the population characteristics for a variable caused by people failing to answer a question.

As noted earlier, this type of bias is the one which presented the greatest problem in this study. Considering only those who answered versions A, B, C (as has been our practice), 38 percent failed to answer for our WTP questions and 16 percent gave a $0 amount. Strictly speaking, the zero amounts are responses and we treated them as such, but they bear further analysis, Since other studies have found that a portion of the zero bids represent protest bids and not true zero valuations, it is appropriate to treat them here under the item nonresponse bias rubric.

Let us consider those who failed to give any amount first, In national surveys it is common for the don't knows to range from 5-10 percent for relatively demanding questions. This was the case with the questions which immediately preceded the WTP items in our questionnaire.

It asked respondents for their water quality preference and received an 11 percent nonresponse rate. In comparison, the 38 percent for the WTP items is obviously high. The three most likely explanations for this are: 1) The general difficulty of WTP questions; 2) The peculiar difficulty of our questions; 3) The interviewing situation for our study. We will discuss each in turn before concluding that a combination of the first and last of these factors is the most likely explanation for our high nonresponse rate.

WTP surveys are very demanding of respondents and it should not be surprising if, for comparable samples, they experience higher item non-response rates that surveys using more common types of question. The WTP instrument asks the respondent to attend to a description of the hypothetical market which is necessarily detailed. It requires the respondent to value in dollars an amenity the respondent does not customarily view in that manner. This is an intellectually demanding task and requires a motivational commitment which may be lacking for people for whom the public good being valued is not particularly salient. We reviewed 13 WTP studies to compare their item nonresponse rates on their WTP questions, Unfortunately, less than half of these studies provide enough information about item nonresponse to enable us to include them in the comparison. For the six which did, the rates ranged from 1 percent for Robert Davis' pioneering study of visits to the Maine woods (Knetsch and Davis, 1966) to 32 percent for a sales tax vehicle used to study the value of air visibility in the

Four Corner's area (Randall, et al., 1974). In between were item non-response rates of 2 percent (elk licenses, Brookshire, et al., 1980), 8 percent (damage from surface mining, Randall, et al., 1978), 11 percent, (air visibility, Brookshire, et al., 1980).[17] 14 percent (sales tax, Walsh, et al., 1978), 20 percent (utility bill, Brookshire, et al., 1980), and 21 percent (electric bill, Randall, et al., 1974).

These data suggest the following conclusions: 1) on the average, WTP studies tend to have somewhat higher item nonresponse rates than regular survey questions and yet 2) under certain conditions these rates are very low. In Davis' case, he personally conducted all his interviews in the Maine woods and reports very high rapport with his respondents. The elk license payment vehicle of Brookshire, et al. (1980) is specifically and traditionally tied to the good being valued. Because entrance fee vehicles have the same characteristics, we would also expect them to have low item nonresponse rates. Studies like ours which use bidding vehicles that are less specific or traditionally tied to the good may expect higher item nonresponse rates.

The second hypothesized cause of item nonresponse is our question wording. While we have identified minor changes which will make the questions clearer and more interesting to the respondents we are not aware of serious problems in this area. In our pretest with a specially trained interviewer only two people of 38 failed to give WTP amounts.

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[17] Neither of the last two studies specifically report item non-response rates. We infer these values from Randall, et al.'s, "unusable" survey figure and Brookshire, et al.'s "deletions" for reasons not explained (presumably because the respondents gave no amount.

The interview situation is another matter. We believe this is a major contributor to the high item nonresponse for several reasons, First, as noted earlier, we were able to obtain a national sample at low cost because we were able to add the benefits questionnaire to an existing survey, Because of this, as mentioned previously, the WTP instrument was administered after the respondents (and the interviewer) had already spent at least a half hour on the environment/energy survey. For certain categories of people, especially the aged and those with low levels of education, the preceeding interview probably took longer than a half hour with correspondingly greater fatigue effects. Second, because our budget was limited, (and our purposes experimental) we did not provide the interviewers with the kind of detailed instructions which we would provide for a full scale benefit estimation study. These instructions would include procedures for handling various types of respondent: queries and instructions for encouraging reluctant players to give WTP amounts. Third, the same budget constraints restricted the length of our WTP instrument. The addition of several followup questions in the instrument itself which would probe non-responses (and zero amounts) would enable us to identify respondents who would give us WTP amounts after further explanations.

To summarize, the most likely explanation for our high item non-response rate is a combination of the inherent difficulty of WTP questions, and the limitations of our interview situation. Appropriate changes in the latter, combined with a fine tuning of the questions, should reduce the item nonresponse rate to a tolerable level, Because of the inherent

difficulty of these types of questions, it will be very difficult to bring item nonresponse rates from 10-15 percent for WTP surveys of the general public. Rates of this level should not unduly bias the final estimates if weighting procedures are used to compensate for the nonrespondents. We discuss these matters further in Chapter 6.

How will our item nonresponse rate of 39 percent bias these data? Put another way, this question becomes: What kinds of people failed to respond to our WTP questions? We estimated a logit regression equation for a combination of background variables and key attitude items which is presented in Table 4.8. Definitions for these variables are given on Table 4.6, page 4-39 The dependent variable is a dummy with the non-respondents set at 1 and all those who gave WTP amounts greater than zero for fishable water at 0. (Thus we drop those who gave zero amounts from the following analysis). The overall predictive accuracy coefficient of .27 indicates a moderate fit. Older people, blacks and those who are uncertain about the nation's water quality goals (0.81 SPRECHLD) were especially likely (p. = .OO1> and those respondents low in income and education were very likely (p. = .O1> to be among the nonrespondents. The respondent's sex and use of water for recreation were also significantly related to the dependent variable. This profile is consistent with the hypothesis that people for whom the issue is less salient (SPRECHLD, RACED) and/or for whom the WTP instrument is difficult to answer(AGECAT, EDUC, SPRECHLD) are more likely to be among the nonrespondents to the WTP items. It is noteworthy that environmental and water quality attitudes (ENVINDEX, CNPOLD) are not significant in this equation.

Table 4.8

LOGIT[1] REGRESSIONS RELATING BACKGROUND AND ATTITUDINAL VARIABLES TO CERTAIN TYPES OF WILLINGNESS TO PAY RESPONSES FOR FISHABLE WATER[2]

Independent Variables	Dependent variable; 1 = zero wtp amount; 0 = WTP amount greater than zero	Dependent variable; 1 = 'don't know' how much willing to pay 0 = WTP amount greater than zero
Intercept	2.3**	2.8***
INCOMER	-.0002*	-.00002**
EDUC	-.42***	-.23**
AGECAT	.14**	.09***
RACED	-.95**	-1.38***
SEXD	-.10	.39*
USERD	-1.11***	-.44*
ENVINDEX	-.44***	-.08
CNPOLD	-.23	-.15
SPRECHLD[3]	-.96**	-1.68***
N	695	783
Likelihood ratio index	.31	.18
R^2 index (D)	.25	.19
Percent correctly predicted		
zero amounts	84%	don't know 77%
other amounts	86	other amounts 78
Predictive accuracy coefficient	.47	.27

* p < .05 / ** p < l .01 / *** p < .001

[1]Maximum likelihood estimates are computed by the Newton-Raphson method. (SAS Institute, 1980).

[2]For Versions A, B, and C combined.

[3]Dummy variable where 1 = nation should plan to achieve nationwide water quality of fishable or better within the next five years (Q.81); 0 = all other responses of which "not sure" comprises two-thirds and preference for nationwide water quality lower than fishable comprises one-twelfth.

From what we know about the willingness to pay for water quality of other respondents, the bias given our estimates by the high item non-response rate is upwards. The older, less educated and lower income people who expressed WTP amounts gave lower amounts, other things being equal, than their peers, and we would expect the addition of a significant number of the nonrespondents to those giving WTP amounts to lower the mean WTP value for water quality.

Turning now to the zero amounts, sixteen percent of our sample gave WTP amounts of $0 for fishable water. It is very difficult to compare this with the experience of other WTP studies since only four of the 13 studies reviewed report the total percent of $0 bids. For these studies the zero amounts varied as follows: 1 percent, Maine Woods (Knetsch and Davis, 1966); 2 percent for sales tax vehicle and 26 percent for utility bill option, water quality in the South Platte River Basin (Walsh, et al., 1978); 6 percent for non-reservation residents, air pollution visibility in Four Corner's area (Randall, et al., 1974); and 7-32 percent, depending on WTP version, decreased risk from nuclear plant accidents (Mulligan, 1978). Our level of zero amounts is somewhere in the middle of this distribution, but we do not regard this level of zero amounts as acceptable, especially since we already have a high non-response rate for the WTP questions.

The factors discussed above for nonresponse are also the likely cause of the zero amounts. Question wording probably played a much larger role in stimulating the zero responses, however. Endeavoring to legitimate low values for respondents who might have been hesitant to express their "true" feelings about water quality, we ended the first WTP question in the series by saying: "If it is not worth anything to you, please do not hesitate to say so." In retrospect we believe this was too strong a statement which unnecesarily promoted zero responses by some who probably have valued water at greater than zero but who were reluctant to undertake the mental effort necessary to arrive at that value. We will substitute another type of encouragement to respondents to give their true value in any future use of our instrument.

We estimated a logit regression for a dummy variable with zero WTP set at 1 and those who gave amounts greater than zero at 0. This regression is also reported in Table 4.7. This estimation has superior predictive power to the parallel one for nonrespondents (predictive accuracy coefficient of .47). Comparing the two equations we find recreational use and environmentalism play a greater role in predicting the zero bidders, who tend to use water less and are weaker in their support for environmentalism. These findings are consiste with the hypothesis that zero bids do represent low (if not zero) value for water quality. However, the importance of age, also significant in the equation at the .001 level, and the role of race and education (.01),

parallel their place in the nonresponse equation and suggests that zero bids may also be partially due to people protesting the WTP format or expressing an unwillingness to answer the question.

The bias introduced by the large number of zero bidders is to make our estimates lower than they would be if we had fewer zero bidders. From the findings of other WTP studies which have asked their zero bidders why they bid zero (Rowe, et al., 1979a; Thayer forthcoming, Brookshire, et al., 1980; Brookshire, et al., 1976) it seems very likely that some of our zero bidders are probably protesting the instrument rather than really valuing water quality at $0. An indeterminate number of the remaining zero bidders, while not protesting, nevertheless probably value water quality at least somewhat higher than $0 and could be induced to bid higher by the changes described above.

(continue)

Interview Procedure and Interviewer Biases

Two other interview method biases remain to be discussed. The interview procedure-bias refers to bias introduced by the manner of conducting the interview. Interviewing takes place by either personal interview, telephone or mail. The differences involved in choosing between these methods including cost, return rate, ease of asking sensitive questions, and ease of asking complex questions. Although it is the most expensive method, the personal interview method is superior to the other methods on all dimensions (Dillman, 1978:74-76; on social desirability see Bradburn and Sudman, 1979:8). The personal interview method is especially preferable for WTP surveys because it permits the researcher to use visual displays such as our ladder and payment cards and it is the most successful of these methods when the questions are potentially tedious and boring (Dillman, 1978:75). The only viable alternative would be the mail survey, a method used only twice in a WTP study to our knowledge (Bishop and Heberlein, 1980; Fish and Wildlife Service, 1975) as the need to create the hypothetical market in sufficient detail is too wordy for phone interviews.

Unlike the mail surveys, personal interview surveys are open to potential interviewer bias. This type of bias consists of differential effects introduced by the individual interviewers. In a bidding game, for example, some interviewers may be more skillful in inducing respondents to increase their bids above the starting point more than others. If a study uses relatively few interviewers who conduct 25 interviews or more, it is possible to test for interviewer effects by holding the respondents'

personal characteristics (such as income) constant and comparing the mean WTP amounts to see if they differ significantly. Because Roper used 100 interviewers scattered across the country to conduct our interviews, the number of interviews per interviewer is too few to conduct this type of test. With that many interviewers we would expect individual interviewer effects, if there are any, to average out. There is always the possibility that the interviewer training may induce all the interviewers in a project to obtain higher bids than interviewers trained by someone else might with the same questionnaire, but there is no easy way to test for this other than to conduct elaborate methodological experiments. One advantage of our payment card technique is that it minimizes the potential interviewer effect on the WTP amount as compared with the bidding game method.

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

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

[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.

Combined Amounts

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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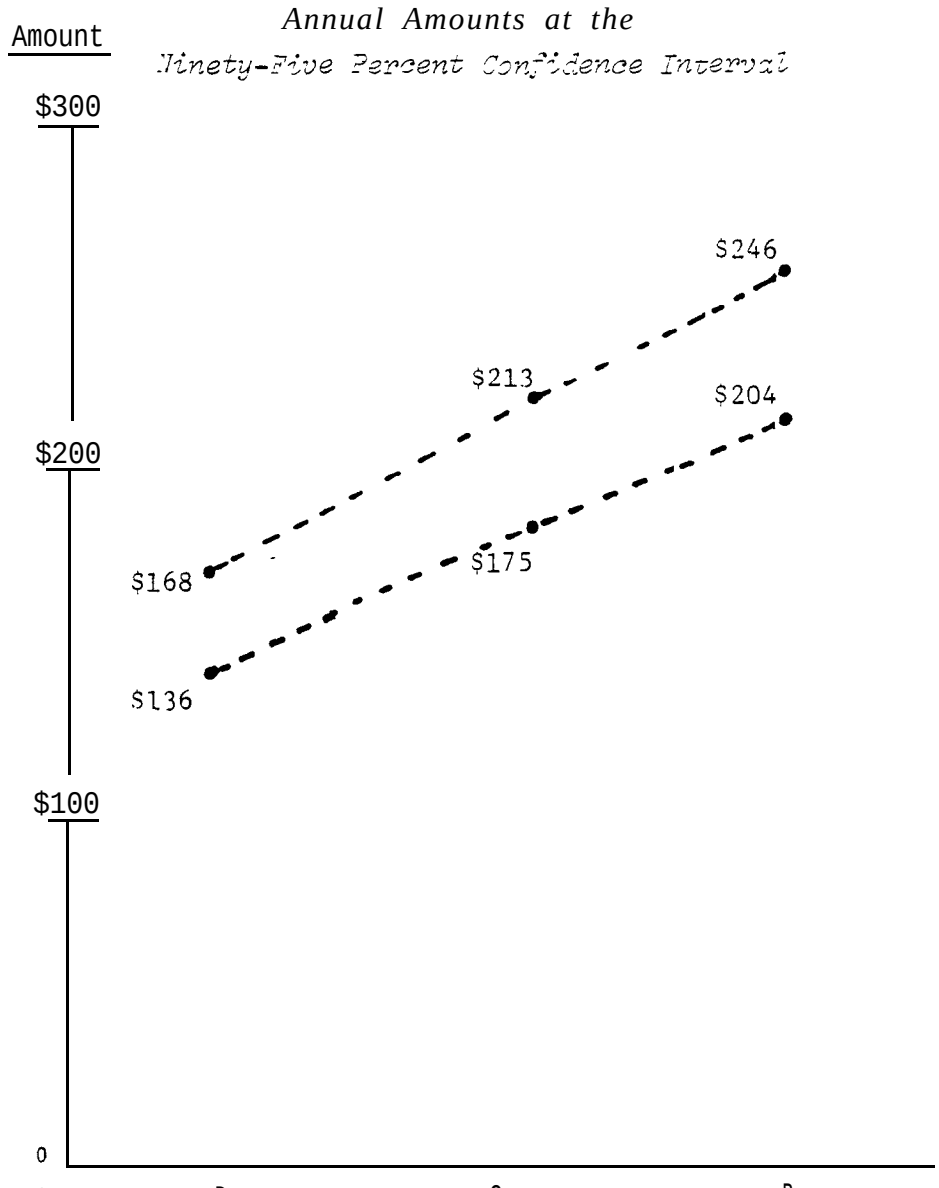
[2]The mean amount which this sample of people is willing to pay for swimmable water quality is approximately the amount paid in taxes and higher prices in 1979 for water pollution control by U.S. households according to the estimates of the President's Council on Environmental Quality. The CEQ estimate 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.

WHAT PEOPLE ARE WILLING TO PAY EACH YEAR PER HOUSEHOLD

Figure 5.1 FOR DIFFERENT LEVELS OF NATIONAL WATER QUALITY



[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%	
$4,000 to $5,999	7	I
$6,000 to $7,999	5	
$8,000 to $9,999	7	
$10,000 to $11,999	7	II
$12,000 to $14,999	9	
$15,000 to $19,999	13	III
$20,000 to $24,999	15	
$25,000 to $49,999	19	IV
$50,000 and over	3	
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]

Concern About Water Pollution -- 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.

Recreational Use of Water -- 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

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

and the variance of the GLS estimator is

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

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) $\text{Log(Leve1 X)} = \text{Intercept} + \beta_1 \text{Log(Income)}$

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

(2) $\text{Log(Leve1 X)} = \text{Intercept} + \beta_1 \text{Log(Income)} + \beta_2 \text{Educ} + \beta_3 \text{Age} + \beta_4 \text{ENVINDEX} + \beta_5 \text{USERD} + \beta_6 \text{CNPOLD}$

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 not 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

[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	Recreational Use of Water in last two years USERD /	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 as Percent of Total Benefits
	Intrinsic	User	Total	
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

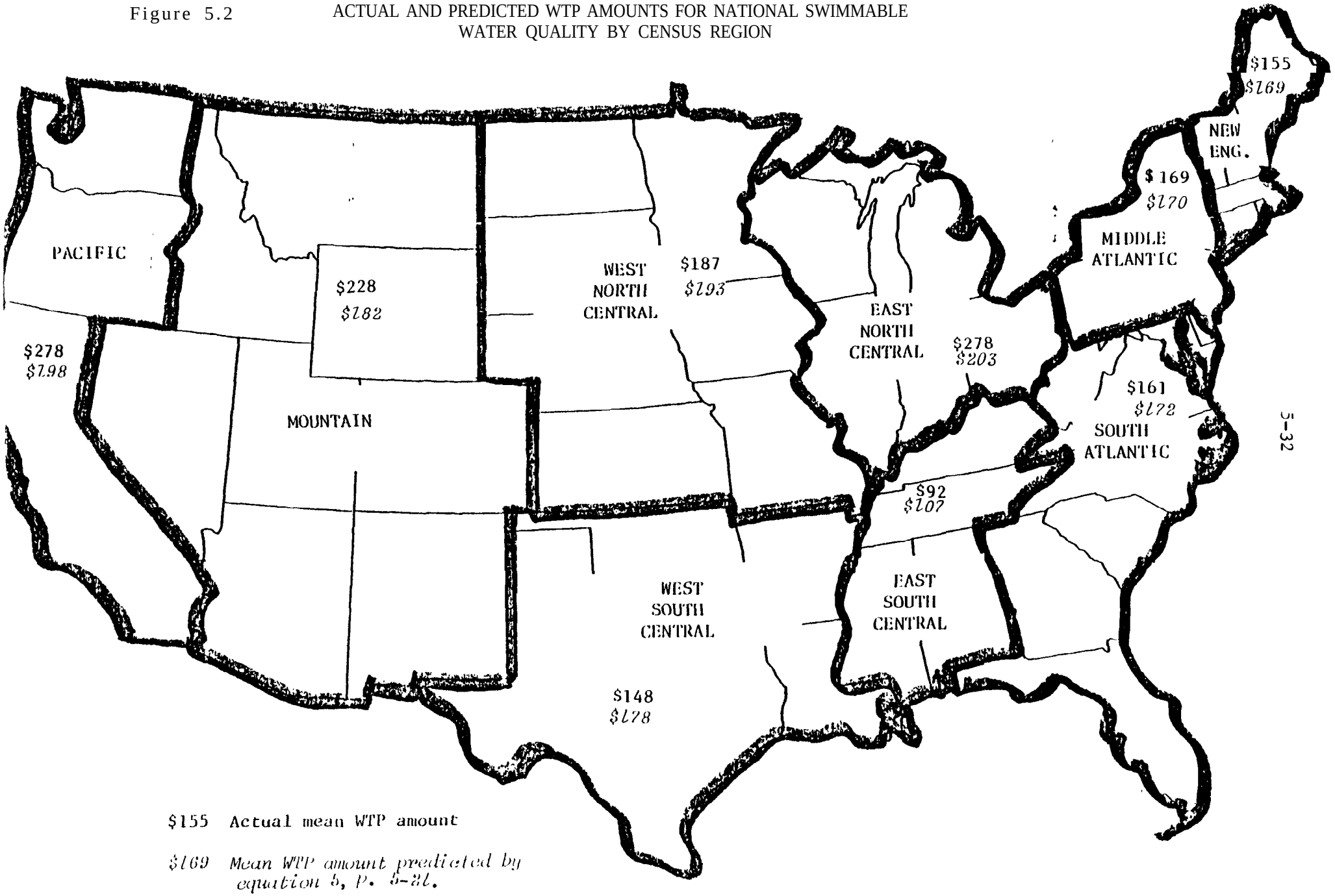
[1] Versions A, B, C combined. Estimated using equation 7 , Table 5.7.

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



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
Survey Context and Construction				
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	
Response				
Inclusion of Protest Zero's		X		
	X			
Traditional Biases				
Strategic			?X	
Hypothetic	?X			
Estimation Techniques				
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 of the survey using several/research organization's interviewers to interview 50-100 approximately / 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 is sufficiently large (e.g. N=2000), 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

[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."

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Appendix I THE RFF RESEARCH INSTRUMENT

STUDY #684 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 (ASK 83)

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 (ASK 84)

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

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?

Version A + C only

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.

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)

82. Improving the quality of the nation's water is just one of many things we all have to pay for as taxpayers 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 D-I, D-II, D-III OR D-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.

You will also see on the scale card the amount of money the average household in your general income category paid last year in taxes and higher prices to improve the water quality of the nation's lakes and rivers. This share of the nation's expenditures to fight water pollution has meant that so far the average quality of these bodies of water has been raised from level E to level D on the ladder. (POINT TO LEVELS E AND D ON WATER QUALITY LADDER CARD) If this amount of money continues to be spent each year, the quality of the water will be raised up to level C (POINT TO LEVEL C) in the next few years--that is, where virtually all of it would be at least clean enough for fishing.

First, as far as you are concerned, are you willing to pay this amount each year to raise water quality to level C or not?

Yes, willing.....	1	(ASK 83)
Depends (vol.).....	2	
No, not willing.....	3	(SKIP TO 84)
Not sure.....	4	

83. What about getting the nation's lakes and rivers up to level B on the ladder? Including the amount of money indicated on the card to get water quality up to level C, how much are you willing to pay in taxes and higher prices each year to raise the water quality to level B--that is where virtually all the nation's lakes, rivers and streams are at least clean enough to swim in safely?

Write in amount: $_____		
Depends (vol.).....	00X	(SKIP TO NAME AND ADDRESS RECORDING BELOW)
Not sure.....	00Y	
Not worth anything.....	001	

84. What about the amount of money to keep the quality of water at level D? How much do you think you would be willing to pay each year in taxes and higher prices, if anything, to keep the nation's overall water quality from slipping below level D to level E where it once was? If it is not worth anything to you, please do not hesitate to say so.

Write in amount: $_____	
Depends (vol.).....	00X
Not sure.....	00Y
Not worth anything.....	001

Name: _____

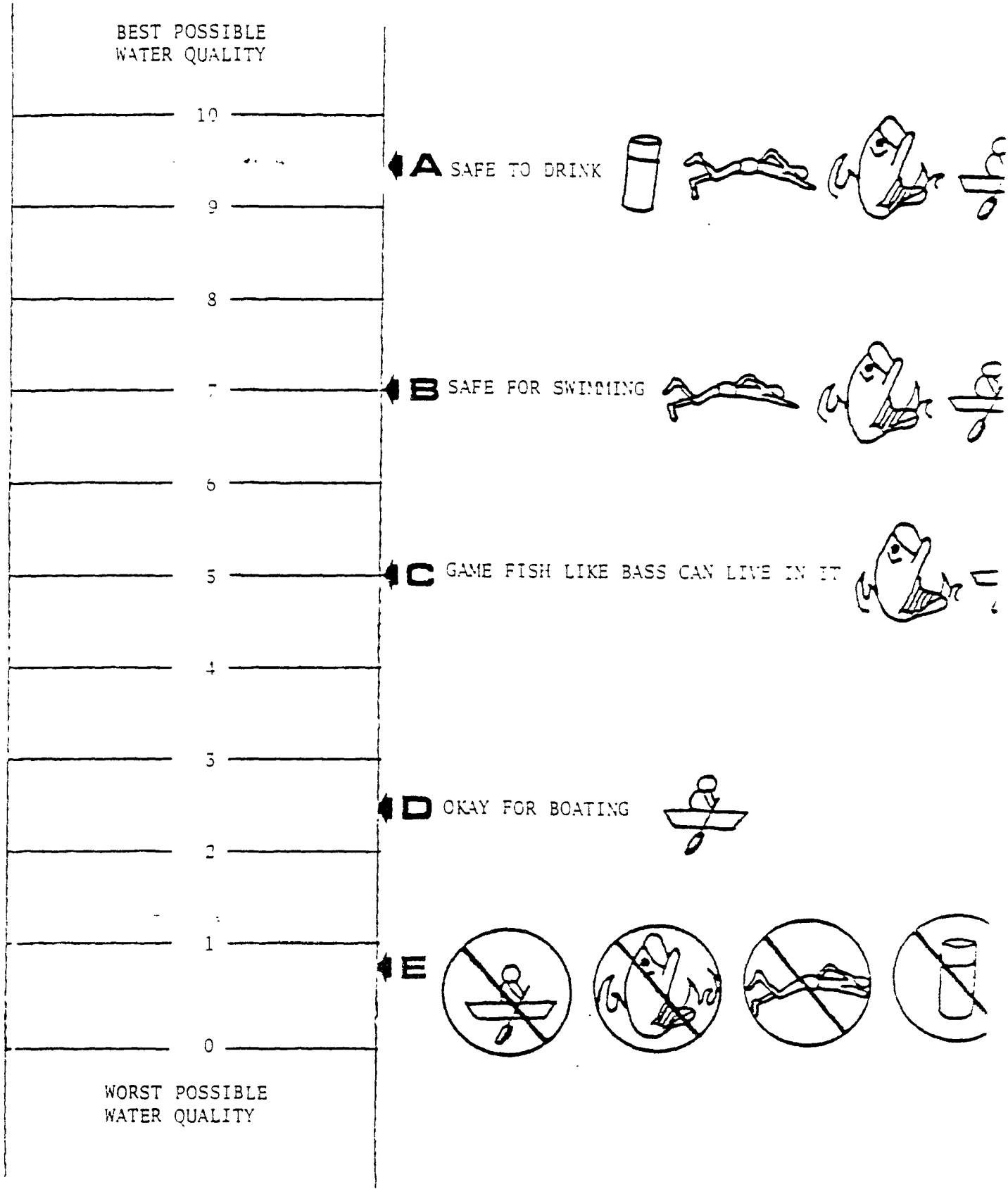
Address: _____

_____

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

A, B, C, D

(WATER QUALITY LADDER CARD)



A-I

(SCALE CARD)

#684

ANNUAL AMOUNT IN TAXES AND HIGHER PRICES

- Space Program	- Highways	- Public Education	- Defense
$ 0	$ 75	$150	$300
5	80	160	310
10	85	170	320
15	90	180	330
20	95	190	340
25	100	200	350
30	105	210	360
35	110	220	370
40	115	230	380
45	120	240	390
50	125	250	400
55	130	260	410
60	135	270	420
65	140	280	430
70	145	290	440

A-II

(SCALE CARD)

#684

ANNUAL AMOUNT IN TAXES AND HIGHER PRICES

- Space Program	- Highways	- Public Education	- Defense
$ 0	$180	$400	$655
10	190	415	670
20	200	430	685
30	210	445	700
40	220	460	715
50	230	475	730
60	240	490	745
70	250	505	760
80	265	520	775
90	280	535	790
100	295	550	805
110	310	565	820
120	325	580	835
130	340	595	850
140	355	610	865
150	370	625	880
160	385	640	895

A-III

(SCALE CARD)

#6

ANNUAL AMOUNT IN TAXES AND HIGHER PRICES

- Space Program	- Highways	- Public Education	- Def
$ 0	$270	$ 660	$1200
15	285	690	1230
30	300	720	1260
45	315	750	1290
60	330	780	1320
75	345	810	1350
90	360	840	1380
105	375	870	1410
120	390	900	1440
135	405	930	1470
150	420	960	1500
165	450	990	1530
180	480	1020	1560
195	510	1050	1590
210	540	1080	1620
225	570	1110	1650
240	600	1140	1680
255	630	1170	1710

A-IV

(SCALE CARD)

#

ANNUAL AMOUNT IN TAXES AND HIGHER PRICES

- Space Program	- Highways	- Public Education	- Def
$ 0	$450	$1200	$2550
25	475	1275	2625
50	500	1350	2700
75	525	1425	2775
100	550	1500	2850
125	575	1575	2925
150	600	1650	3000
175	625	1725	3075
200	650	1800	3150
225	675	1875	3225
250	700	1950	3300
275	725	2025	3375
300	750	2100	3450
325	775	2175	3525
350	800	2250	3600
375	875	2325	3675
400	950	2400	3750
425	1125	2475	3825

5	$ 75	180	655
10	80	190	670
15 - Space Program	85	200	685
20	90	210	700
25 - Police & Fire	95	220 - Public Education	715
30	100	230	730
35	105	240	745
40	110	250	760
45	115	260	775
50	120	270	790
55	125	280	805
60	130	290	820
65	135	300	835
70	140	310	850
75	145	320	865
80	150	330	880
85	155	340	895
90	160	350	910
95	165	360	925
100	170	370	940
105	175	380	955
110	180	390	970
115	185	400	985
120	190	410	1000
125	195	420	1015
130	200	430	1030
135	205	440	1045
140	210	450	1060
145	215	460	1075
150	220	470	1090
155	225	480	1105
160	230	490	1120
165	235	500	1135
170	240	510	1150
175	245	520	1165
180	250	530	1180
185	255	540	1195
190	260	550	1210
195	265	560	1225
200	270	570	1240
205	275	580	1255
210	280	590	1270
215	285	600	1285
220	290	610	1300
225	295	620	1315
230	300	630	1330
235	305	640	1345
240	310	650	1360
245	315	660	1375
250	320	670	1390
255	325	680	1405
260	330	690	1420
265	335	700	1435
270	340	710	1450
275	345	720	1465
280	350	730	1480
285	355	740	1495
290	360	750	1510
295	365	760	1525
300	370	770	1540

A-I-7

II-

(SCALE CARD)

#684

ANNUAL AMOUNT IN TAXES AND HIGHER PRICES

$ 0	$180	$400	$655
10	190 - Highways	415	670 - Defense
20 - Space Program	200	430	685
30	210	445 - Public Education	700
40	220	460	715
50	230	475	730
60	240	490	745
70	250	505	760
80	265	520	775
90	280	535	790
100 - Police & Fire	295	550	805
110	310	565	820
120	325	580	835
130	340	595	850
140	355	610	865
150	370	625	880
160	385	640	895

B -IV

(SCALE CARD)

#684

ANNUAL AMOUNT IN TAXES AND HIGHER PRICES

$ 0	$ 450 - Police & Fire	$1200	$2550
25	475	1275	2625
50	500	1350	2700
75	525	1425	2775
100	550	1500	2850
125 - Space Program	575	1575	2925
150	600	1650	3000 - Defense
175	625 - Highways	1725	3075
200	650	1800	3150
225	675	1875	3225
250	700	1950 - Public Education	3300
275	725	2025	3375
300	750	2100	3450
325	775	2175	3525
350	800	2250	3600
375	875	2325	3675
400	950	2400	3750
425	1125	2475	3825

C-III

(SCALE CARD)

ANNUAL AMOUNT IN TAXES AND HIGHER PRICES

#684

$ 0		$ 75		$150		$ 305	
5		80		160		315	
10		85		170		330	
15	- Space Program	90		180		0	
20		95		190		0	
25		100		200		360	
30		105		210		265	
35		110		220		370	
40		115		230		380	
45		120		240		390	
50		125	- Highways	250	- Public Education	400	- Defense
55		130		260		410	
60		135		270		420	
65		140		280		430	
70		145		290		440	

C-IIII

(SCALE CARD)

ANNUAL AMOUNT IN TAXES AND HIGHER PRICES

#684

0		450		900		1250	
15		465		690		1270	
30		300		720		1290	
45		315		750		1290	
60	- Space Program	330		0		1330	
75		345		810		1350	
90		360		840		1370	
105		375		870		1410	
120		390	- Highways	900		1440	
135		405		930		1470	
150		420		960		1500	
165		450		990		1530	
180		480		1020		1560	
195		510		1050		1590	
210		540		1080		1620	
225		570		1110	- Public Education	1650	- Defense
240		600		1140		1680	
255		630		1170		1710	

A-1-8

C-II

(SCALE CARD)

ANNUAL AMOUNT IN TAXES AND HIGHER PRICES

#684

$ 0		$180		$400		$655	
10		190		415		670	
20		200		430		685	
30	- Space Program	210		445		700	
40		220		460		715	
50		230		475		730	
60		240	- Highways	490		745	
70		250		505		760	
80		265		520		775	
90		280		535		790	
100		295		550	- Public Education	805	
110		310		565		820	
120		325		580		835	- Defense
130		340		595		850	
140		355		610		865	
150		370		625		880	
160		385		640		895	

C-IV

(SCALE CARD)

ANNUAL AMOUNT IN TAXES AND HIGHER PRICES

#684

$ 0		$ 450		$1200		$2550	
25		475		1275		2625	
50		500		1350		2700	
75		525		1425		2775	
100		550		1500		2850	
125		575		1575		2925	
150	- Space Program	600		1650		3000	
175		625		1725		3075	
200		650		1800		3150	
225		675		1875		3225	
250		700		1950		3300	
275		725		2025		3375	
300		750		2100		3450	
325		775	- Highways	2175		3525	
350		800		2250		3600	
375		875		2325		3675	
400		950		2400		3750	- Defense
425		1125		2475	- Public Education	3825	

D-I

(SCALE CARD)

#684

ANNUAL AMOUNT IN TAXES AND HIGHER PRICES

$ 0		$ 75	$150	$300
5		80	160	310
10	- Space Program	85	170	320 - Defense
15		90	180	330
20		95 - Highways	190	340
25		100	200 - Public Education	350
30		105	210	60
35		110	220	370
40		115	230	380
45		120	240	390
50		125	250	400
55		130	260	410
60	- WATER POLLUTION CONTROL	135	270	420
65		140	280	430
70		145	290	440

D-II

(SCALE CARD)

#684

ANNUAL AMOUNT IN TAXES AND HIGHER PRICES

$ 0		$180	$400	$655
10		190 - Highways	415	670 - Defense
20		200	430	685
30	- Space Program	210	445 - Public Education	700
40		220	460	715
50		230	475	730
60		240	490	745
70		250	505	760
80		265	520	775
90		280	535	790
100		295	550	805
110		310	565	820
120	- WATER POLLUTION CONTROL	325	580	835
130		340	595	850
140		355	610	865
150		370	625	880
160		385	640	895

D-III

(SCALE CARD)

#684

ANNUAL AMOUNT IN TAXES AND HIGHER PRICES

$ 0		$ 720	$ 660	$1200
15		735	690	1230
30		300 - Highways	720	1260
45	- Space Program	315	750	1290
60		330	780	1320 - Defense
75		345	810	1350
90		360	840	1380
105		375	870 - Public Education	1410
120		390	900	1440
135		405	930	1470
150		420	960	1500
165		450	990	1530
180		480	1020	1560
195		510	1050	1590
210		540	1080	1620
225		570	1110	1650
240	- WATER POLLUTION CONTROL	600	1140	1680
255		630	1170	1710

D-IV

(SCALE CARD)

#684

ANNUAL AMOUNT IN TAXES AND HIGHER PRICES

$ 0		$ 450	$1200	$2550
25		475	1275	2625
50		500	1350	2700
75		525	1425	2775
100	- Space Program	550	1500 - WATER POLLUTION CONTROL	2850
125		575	1575	2925
150		600	1650	3000 - Defense
175		625 - Highways	1725	3075
200		650	1800	3150
225		675	1875	3225
250		700	1950 - Public Education	3300
275		725	2025	3375
300		750	2100	3450
325		775	2175	3525
350		800	2250	3600
375		875	2325	3675
400		950	2400	3750
425		1125	2475	3825

Appendix II

THE WATER QUALITY LADDER

William J. Vaughan

Water quality can either be described in terms of the uses for which a particular body of water is suitable or in terms of the objective characteristics of the water itself. In turn, objective characteristics traverse a continuum from those that are readily perceptible to those that can only be detected by scientific measurement. In certain dimensions (e.g., visible phenomena such as the extent of algal growth, the clearness of the water, and the existence of suds, foam or debris (David, 1971)) people at large find it easy to preceive changes in water quality. However, some characteristics which delineate water quality levels more finely, such as dissolved oxygen content, escape visual and olfactory perception. Thus it is not surprising that people's ratings of water quality levels are likely to exhibit a less-than-perfect degree of association with any one or a combination of the several scientific measures of quality conditions (Binkley and Hanemann, 1978). This poses a problem for benefit estimation because the existence of a positive willingness to pay for water quality improvement depends upon the ability of people to perceive water quality changes when such changes do, in fact, occur.

This problem has lead previous investigators either to attempt to engineer the fortunate marriage of an objective water quality index (based on some weighted combination of scientific quality parameters) and a subjective index of publicly perceived quality (Bouwes and Schneider, 1979) or to link subjective indices of public perception. and expert perception (Dornbusch, 1975).

We chose to describe water quality primarily in terms of the uses for which water becomes suitable, and secondarily in terms of a few obvious water quality conditions (clearness, odor, debris, etc.). However, we located the numerical position of the five posited water quality levels (Boatable, Fishable-2 levels, Swimmable, Drinkable) by indexing a set of five objective scientific water quality parameters using a variant of the National Sanitation Foundation's Water Quality Index (Booth et al., 1976; McClelland, 1974) along with informed judgment. In so doing we hope to extablish, ex-ante, an admittedly tenuous link between scientifcally measured quality characteristics (anchors of the rating scale) and perceived water quality characteristics (the use and readily perceivable objective characteristic descriptors of these anchors).

Specifically, a number of sources were consulted to ascertain the minimally acceptable concentration levels of five measurable quality characteristics associated with five potential uses of natural water courses. These were fecal coliforms (organisms/100 ml), dissolved oxygen (mg/1), maximum BOD-5 (mg/1), turbidity (JTU) and pH.[1] The five quality measures were the only ones for which numerical values could be obtained across all use classifications, a requirement dictated by the index approach. Particular attention was given to state water quality standards (North Carolina Environmental Management Commission, Dorfman 1972)) because they report specific critical water quality parameters associated with a set (usually four or five) of descriptive water quality classifications. The consensus results for each quality level are summarized in Table 1.

---

[1]Sources consulted include Thomann (1971), U.S.G.S. (1978), Pickle et al. (1973), Davis (1968)), Economics Research Associates (1979), Katz (1969), Dorfman et al. (1972), North Carolina Environmental Management Commission, APHA, AWWA and FSIWA (1955), National Technical Advisory Committee (1968), NAS-NAE (1972), EPA (1976), Davidson, Adams and Seneca (1966), National Planning Association (1975).

Table 1. Consensus Water Quality Characteristics of Five Water Quality Classes

Water Quality Classification	Measurable Water Quality Characteristics				
	Petal Coliforms (#/100 ml)	Dissolved Oxygen (mg/1)[a/]	5-day BOD (mg/1)	Turbidity (JTU)	Ph
Acceptable for drinking without treatment	0	7.0 (90)	0	5	7.25
Acceptable for swimming	200	6.5 (83)	1.5	10	7.25
Acceptable for game fishing	1000	5.0 (64)	3.0	50	7.25
Acceptable for rough fishing	1000	4.0 (51)	3.0	50	7.25
Acceptable for boating	2000	3.5 (45)	4.0	100	4.25

a/ Percent saturation at 85°F in parentheses

In order to associate each of the five possible sets of scientific measures with a single-valued ordinate or the quality ladder a truncated version of the National Sanitation Foundation Water Quality Index (WQI) was used:

$$WQI = \prod_{i=1}^{5} q_i^{\hat{\omega}_i} / 10$$

where

q_i = the quality of the i^{th} parameter, a number from 0 to 100 obtained from the transformation functions for water quality measures in McClelland (1974).

$\hat{w}_i$ = the weight assigned to the i^{th} parameter. The original weights (w_i) reported in McClelland (1971) cover nine quality measures and

$$\sum_{i=1}^{9} = 1.00$$

Our adjusted weights cover a smaller number of measures which also sum to 1.0 from:

$$\hat{\omega}_i = w_i \left(\sum_{i=1}^{9} \omega_i \Big/ \sum_{i=1}^{5} \omega_i \right)$$

The resultant ladder appears in Figure 1.

For example, the index value for the "Acceptable for Rough Fishing" classification was developed as shown below:

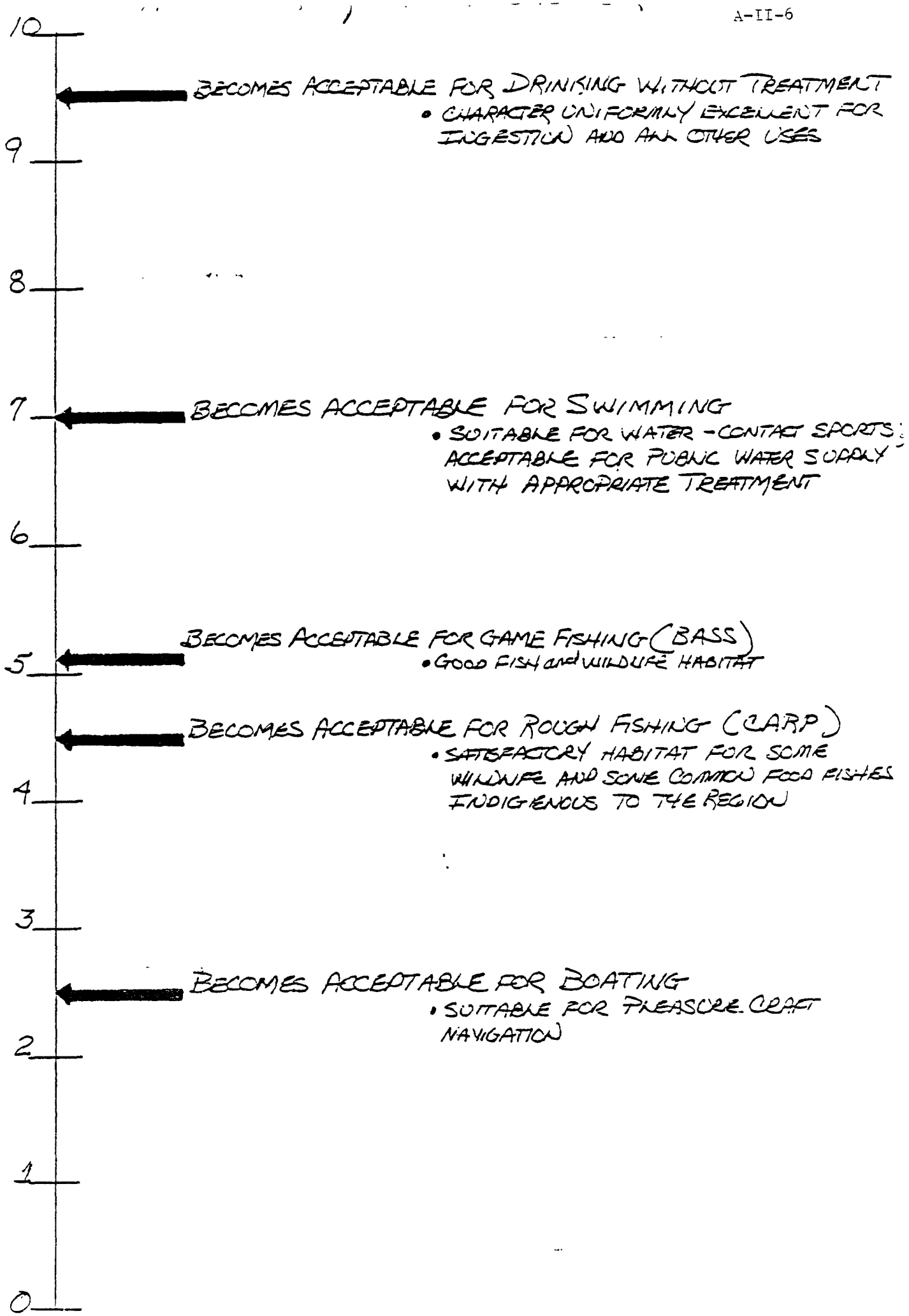
Characteristic	Value	Scaled Value (q_i)	Weight ($\hat{w}_i$)	Weighted Scale Value ($q_i \hat{w}_i$)
Fecal Coliform	1000/100m1	20	0.242	1.985
Dissolved Oxygen	51%[a/]	44	0.274	2.820
Max 5-Day BOD	3 mg/1	74	0.161	2.000
Turbidity	50 JTU	38	0.129	1.599
~~pH~~ Ph	7.25	93	0.194	2.049
				4.5

pH Index $\left(\prod_{i=1}^{5} q_i^{\hat{w}_i} / 10\right)$

Notes:

[a/] Percent saturation at 85°F.

Similar calculations for the remaining four classes yield the water quality ladder shown in Figure 1.


10
9
8
7
6
5
4
3
2
1
0
BECOMES ACCEPTABLE FOR DRINKING WITHOUT TREATMENT
• CHARACTER UNIFORMLY EXCELLENT FOR INGESTION AND ALL OTHER USES
BECOMES ACCEPTABLE FOR SWIMMING
• SUITABLE FOR WATER-CONTACT SPORTS; ACCEPTABLE FOR PUBLIC WATER SUPPLY WITH APPROPRIATE TREATMENT
BECOMES ACCEPTABLE FOR GAME FISHING (BASS)
• GOOD FISH and WILDLIFE HABITAT
BECOMES ACCEPTABLE FOR ROUGH FISHING (CARP)
• SATISFACTORY HABITAT FOR SOME WILDLIFE AND SOME COMMON FOOD FISHES INDIGENOUS TO THE REGION
BECOMES ACCEPTABLE FOR BOATING
• SUITABLE FOR PLEASURE CRAFT NAVIGATION

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Appendix III DERIVATION OF PUBLIC GOODS EXPENDITURES

The estimated public goods expenditures used in this study to "anchor" the amounts displayed on the payment cards are shown in Table I below:

Table 1: Public Goods Expenditure Estimates for Versions A, B, C, D by Income Class

Income Category	Public Good (Average Expenditure per Household)					
	Defense	Education	Highways & Roads	Water Pollution	Police & Fire	Space
I. Less than $10,000	$ 322 (402)	$ 204 (255)	$ 98 (123)	$ 61	$ 33	s 13 (16)
II. $10-15,000	676 (845)	446 (557)	192 (240)	125	70	27 (34)
III. $15,25,000	1337 (1671)	882 (1103)	312 (390)	245	139	53 (66)
IV. $25	3013 (3766)	1988 (2485)	626 (782)	562	313	120 (150)

These amounts were used to anchor the payment card amounts as follows:

1. Version A used four public goods (Defense, Education, Highways, and Space Program).

2. Version B used five public goods (Defense, Education, Highways, Police and Fire Protection, and Space).

3. Version C used the four public goods listed for A. The public goods expenditures used in Version C were 25% higher than those used in Version A. These amounts are shown in parenthesis.

4. Version D used the four public goods and amounts as in Version X plus the amounts shown from Water Pollution.

Methodology

Since we desired to take account of public goods expenditures that were the result of both direct taxes and indirect taxes (usually reflected in higher prices) we used a formula that took into account both direct and indirect taxation. Using the federal tax structure as our base, 43% of taxes come from income taxes (direct) while 57% come from other taxes and charges. Internal Revenue Service figures are also available on the average amount of income tax paid by income category. Aggregating the IRS categories by the weight of the percent of the population in that category, we obtained the average federal income tax paid by our four income classes.[1]

The following formula was used to determine total household expenditures for the federal budget.

$$\text{Average Federal Income Tax Paid (43\%)} + \text{Indirect Taxes (57\%)} = \text{Total Federal Household Expenditures}$$

or

$$\frac{\text{Average Federal Income Tax Paid}}{43\%} = \text{Total Federal Household Expenditures}$$

It is now possible to solve the equation for total federal household expenditures since average federal income tax paid is known and .43 is a constant representing the ratio of income tax to total federal revenues.

---

[1]An exception to this procedure was made in the case of the $0-5,000 income categories. These categories are not included in our calculations for the under $10,000 income class because they pay almost no income taxes and would have distorted our estimate of the non-income expenditures on public goods for the under $10,000 income class. Hence, our estimates of average federal income tax paid by those in the under $10,000 category are biased upward.

From the 1980 United States Budget, defense spending accounts for 24% of total federal expenditures. To calculate a household's (in a given income category) expenditures for defense the following formula was used:

$$24\% \times (\text{Total Household Federal Expenditures}) = \text{Household Defense Expenditure}$$

Expenditures for other public goods were calculated using defense spending as a base.[2]

$$(HED) \times \left[\frac{(TEPGX)}{(TFDE)}\right] = HEPGX$$

where HED = Household Expenditure on Defense
TEPGX = Total Expenditures on Public Good X
TFDE = Total Federal Defense Expenditures
HEPGX = Household Expenditures on Public Good X

For a household in income level I (under $10,000 annual income), expenditures on highways and roads were calculated as follows:

$$\$322 \times \left[\frac{(\$33,700,000,000)}{(\$125,200,000,000)}\right] = \$98$$

where HED = $322
TEPGX = $33,700,000,000
HEPGX = $98
Public Good X = Highways and roads

Estimation Problems

The estimates of the public goods expenditures by income category are only intended to be rough "ball park" figures. They are plagued by a number

[2]The estimates of expenditures on highways and roads included the following correction factor to take account of the regressive nature of gasoline taxes which are largely responsible for financing this public good. For income category I (under $10,000) the estimated household expenditure on highways and roads was multiplied by 120%. For income categories II, III, and IV, the correction factor was +10, and -20, respectively.

of problems some of which are not easily tractable. Since we are attempting to obtain estimates of willingness to pay for water quality at the time of the interview, it is desirable to use as current as possible estimates of expenditures on other public goods. This desire presents three alternatives: (1) using the latest year for which estimates were available for all public goods used which in our case would have been 1976, (2) make the heroic assumption of determining the rate at which expenditures on each public good changed since the last good estimate available, (3) use the latest year available for each public good. We have chosen the third alternative, as the drawbacks of non-comparable years appeared better than old numbers in the case of (1) and the expansion and contraction of several public goods such as water pollution control, defense, and highways out of sinc with any of the standard indexes precluded easy use of (2).

Discrepancies in definitions also pose estimation problems in the case of the Census Bureau's household definition and IRS's definition of non-business income tax returns. In our case, there are 77 million households and 87 million individual and joint income tax returns. We chose to consider households and IRS tax returns and equivalent for the purpose of computing average federal income tax paid.

The most heroic assumption we made was that the other 57% of the federal budget is collected in the same proportion as income tax. These indirect taxes are largely consumption taxes; hence this assumption is probably not warranted. If the public goods expenditures on the payment card showed itself to be sensitive to the exact amount given, then a major effort would be required to achieve more accurate estimates of these expenditures.

Version A and Version C of this survey were explicitly designed to test this sensitivity.

With the exception of the purely federal expenditures of defense and space, our implicit assumption of uniform national expenditures by income category is questionable although highways and roads and water pollution control expenditures violate this assumption to a lesser degree than do police and fire or public education expenditures. (I.e., a resident of New York City pays much more for police protection than does someone in rural Iowa). Further, the respondent, if he or she is familiar with public goods expenditures is most likely to be familiar with expenditures on these two highly local public goods. If our estimates are significantly different from the respondent's perceptions of what they are, the survey may lose credibility in the eyes of the respondent. The extent of this problem, if any, was not explored.

Sources

A. Tax figures -- 1976 IRS preliminary estimates

B. Total-federal income, defense expenditures, space expenditures -- Budget of the United States, 1980.

C. Education figures -- HEW preliminary estimates for primary and secondary education expenditures during the 1978-79 school year.

D. Highways and roads -- American Highway and Transportation Builder's Association for 1978.

E. Water Pollution -- CEQ estimates for total expenditures on water pollution control (December 1978).

F. Police and Fire -- Facts and Figures on Government Finance (Tax Foundation, Inc., 1979).

Appendix IV

FINAL RESULTS OF THE
RESOURCES FOR THE FUTURE

National Environmental Survey

for the President's Council on Environmental Quality

These results are based on a probability sample of 1576 persons, age 18 and over living in the continental United States excluding Alaska. Initially 1286 persons were interviewed in person between January 26 and February 9, 1980. An additional sample of 280 persons were interviewed in person later in March to bring the sample size up to 1576.

All the data reported here have been weighted using standard procedures to compensate for minor variations between the final sample and the actual distribution of basic population characteristics.

In order to include as many questions as possible in the instrument, the sample was split into two equivalent samples. Most questions were asked of the entire sample but some were asked only of the X or the Y half. These questions are identified on the questionnaire. The sample size for the X version is 840 and that of the Y sample is 736.

Robert Cameron Mitchell
Senior Fellow

STUDY NO.684 (1002) JANUARY 1980 COUNTY _____ PLACE _____ Blk.# _____ 5-1

OMB Clearance Number: 116F-79025

Time Started _____ Time Finished _____ Total Minutes _____ 6/7

Hello, I'm _____ from ROPER AND CANTRIL and we're conducting a study all over the country for the United States Government getting people's views about some of the problems the nation faces. Your participation in this survey is entirely voluntary. All information will be held in the strictest confidence and will be used only to produce overall statistical reports. We would very much value your cooperation.

1. First, I would like to ask you which three of these national problems you would like to see the government devote most of its attention to in the next year or two? (HAND RESPONDENT CARD)

a. Reducing racial discrimination	13%	8/
b. Reducing the amount of crime	61	9/
c. Beautifying America	5	10/
d. Conquering "killer" diseases	41	11/
e. Reducing pollution of air and water	24	12/
f. Helping people in poor areas	29	13/
g. Reducing unemployment	48	14/
h. Improving highway safety	-	15/
i. Improving housing and run-down neighborhoods	20	16/
j. Improving public education	35	17/
None	1	18/
No opinion	1	19/

2. There is a lot of talk these days about what the aims of this country should be for the next ten years. On this card are listed some of the goals which different people would give top priority. (HAND RESPONDENT CARD) Would you please say which one of these you, yourself, consider the most important?

	2. Most important (Col.20)	3. Next most important (Col.21)
a. Maintaining a high rate of economic growth	27%	27%
b. Making sure that this country has strong defense forces	14	26
c. Seeing that people have more say in how things get decided at work and in their communities	19	22
d. Protect nature from being spoiled and polluted	9	21
None	-	-
No opinion	1	4

3. And which would be the next most important? (RECORD ABOVE)

4. If you had to choose, which one of the things on this card would you say is most desirable? (HAND RESPONDENT CARD)

	4. Most desirable (Col.22)	5. Second choice (Col.23)
a. Maintaining order in the nation	16%	25
b. Giving the people more say in important government decisions		
c. Fighting rising prices	18	31
d. Protecting freedom of speech	56	22
None	9	17
No opinion	1	5

5. What would be your second choice? (RECORD ABOVE)

6. Here is another list. (HAND RESPONDENT CARD) In your opinion, which one of these is most important?

	6. Most important (Col.24)	7. Next most important (Col.25)
a. Maintaining a stable economy.....	55%	24%
b. Progress toward a less impersonal, more humane society.....	3	14
c. The fight against crime.....	2	37
d. Progress toward a society in which ideas can count more than money.....	9	22
None.....		
No opinion.....	1	3

7. Which is next most important? (RECORD ABOVE)

8. Here is a card that includes all of the goals listed on the three cards you have just looked at. (HAND RESPONDENT CARD) Would you tell me which one of the goals on this card you consider the most desirable of all.

	8 Most desirable (Cols.26,27)	9 Next most desirable (Cols.28,29)	10 Least important (Cols.30,31)
a. Maintaining a high rate of economic growth.....	8%	8%	3%
b. Making sure that this country has strong defense forces...	24	13	5
c. Seeing that people have more say in how things get decided at work and in their communities.....	5	5	8
d. Protecting nature from being spoiled and polluted.....	2	5	9
e. Maintaining order in the nation.....	6	7	2
f. Giving the people more say in important government decisions.....	6	6	4
g. Fighting rising prices.....	25	17	2
h. Protecting freedom of speech.....	2	5	-
i. Maintaining a stable economy.....	11	14	4
j. Progress toward a less impersonal, more humane society	2	2	11
k. The fight against crime.....	5	13	4
l. Progress toward a society in which ideas can count more than money.....	5	3	16
None.....			13
No opinion.....	1	1	8

9. Which is the next most desirable? (RECORD ABOVE)

10. And which one of all the ones on this card is least important from your [illegible]

Now, I'd like to find out how worried or concerned you are about a number of problems I'm 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. First, (ASK ABOUT EACH ITEM)

	A great deal	A fair amount	Not very much	Not at all	No opinion	
a. How worried or concerned are you about the rise in prices and the cost of living?.....	81%	16%	2%	1%	-	31/
b. The problems of the poor?.....	44	42	11	2	1	33/
c. Cleaning up our waterways and reducing water pollution?.....	39	44	13	3	1	34/
d. OMITTED					No col.35	
e. Reducing the amount of unnecessary noise in this community?.....	11	20	34	34	1	36/
f. Shortages of oil, gasoline, coal, natural gas, electricity, or other fuels?.....	73	18	5	2	1	37/
g. Reducing air pollution?.....	36	40	16	-	1	38/
h. The purity of the drinking water in your community?.....	42	27	16	15	1	39/
i. OMITTED					No col.40	

Question asked for RFF in separate Roper survey, March 1980:

9. Now, I'd like to find out how worried or concerned you are about a number of problems I'm 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. First, (ask about each item)

	A great deal	A fair amount	Not very much	Not at all	No opinion
a. How worried or concerned are you about the rise in prices and the cost of living?	86%	11%	2%	1%	-
b. The presence of toxic chemicals such as pesticides or PCBs in the environment?	46	32	16	4	2
c. Cleaning up our waterways and reducing water pollution?	54	33	10	2	1
d. The disposal of industrial chemical wastes that are hazardous?	64	26	-	2	1

TREND ON CONCERN ABOUT INFLATION, ENERGY SHORTAGES,

WATER AND AIR POLLUTION, 1972-1980[1]

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.

		June 1972	April 1974	May 1976	RFF 1980	Roper March
Rise in prices and the cost of living.	*great deal*		83%	75%	79%	86%
	fair amount		12	21	17	11
	not very much		3	3	2	2
	not at all		1	1	2	1
	no opinion		1	0	0	0
	N	1802	1865	1071	1236	c.1500
	composite score	90	93			
Shortages of oil, gasoline, coal, natural gas, electricity and other fuels.	*great deal*	-	57	-	72	
	fair amount	-	24	-	18	
	not very much	-	13	-	5	
	not at all	-	5	-	3	
	no opinion	-	1	-	1	
	composite score	-	78	-		
Cleaning up our waterways and reducing water polluting.	*great deal*	61	51	57	38	54
	fair amount	29	35	32	45	33
	not very much	7	10	7	13	10
	not at all	1	2	2	3	2
	no opinion	2	2	2	1	1
	composite score	84	79	82		
Reducing air pollution.	*great deal*	60	46	55	36	
	fair amount	28	36	32	39	
	not very much	9	12	8	17	
	not at all	1	3	3	7	
	no opinion	2	3	2	1	
	Composite score	83	76	80		

[1] Data for 1972-1976 are from the "State of the Nation" studies done by the Potomac Institute. Only four of the items used in question 11 of the CEQ questionnaire were repeated from the Potomac Institute questionnaires. The composite index is adopted from the Potomac Institute studies. It is calculated by dropping the 'don't knows' and multiplying the number saying 'great deal' by 100, those saying 'fair amount' by 67, 'not very much' by 33 and 'not at all' by 0.

12. Here is a picture of a ladder. (HAND RESPONDENT CARD) Let's suppose the top of the ladder represents the best possible natural environmental situation for our country; that is, all aspects of the environment--air, water, forests, wildlife, waste disposal, noise and the like. Suppose the bottom of the ladder represents the worst possible environmental situation for the United States. Please show me on which step of the ladder you think the environment in the United States is at the present time. (RECORD NUMBER CHOSEN BELOW)

mean 5.24

41/

Don't know..... 1%

13. On which step would you say it was about five years ago?

5.32

42/

Don't know..... 6%

14. Just as your best guess, if things go pretty much as they are now, where do you think the environment in the U.S. will be on the ladder, let us say, about five years from now?

5.08

43/

Don't know..... 7%

15. Thinking now just about the quality of the air in this area. Suppose the top of the ladder represents the cleanest air possible, and the bottom, the most polluted air possible. Please show me on which step of the ladder you think the air around here is at the present time.

6.38

44/

Don't know..... 2%

16. On which step would you say it was about five years ago?

6.31

45

Don't know..... 8%

17. As your best guess, where will it be about five years from now?

6.04

46

Don't know..... 6%

18. Now, thinking just about the quality of the water in the lakes and streams in this area. Suppose the top of the ladder represents the cleanest water possible and the bottom, the most polluted water possible. Please show me on which step of the ladder you think the water in the lakes and streams around here is at the present time.

5.64

47

Don't know..... 9%

19. On which step would you say it was about five years ago?

5.72

48

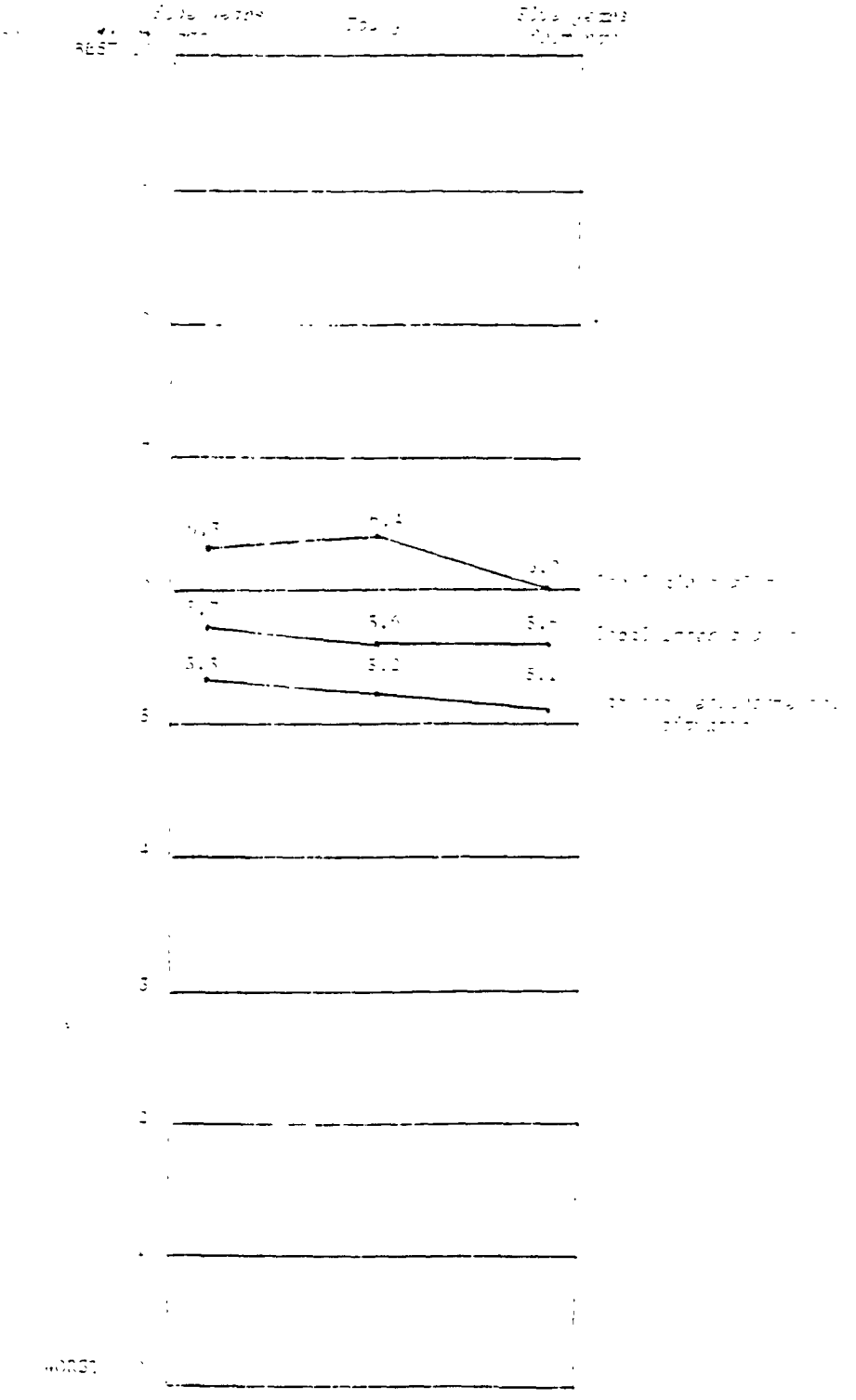
Don't know..... 13%

20. As your best guess, where will it be about five years from now?

5.62

49

MEAN SELF ANCHORED LADDER RANKINGS OF
NATIONAL ENVIRONMENTAL QUALITY, LOCAL WATER
QUALITY AND LOCAL AIR QUALITY FOR PAST, PRESENT AND FUTURE



21. People are affected in different ways by the problems our country faces. For each of the problems I am going to mention, please tell me how much you, yourself, are affected in terms of the kind of life you live and your personal enjoyment of your surroundings. First, the energy shortage: would you say it affects you a great deal, a fair amount, just a little, or not at all? (ASK ABOUT EACH ITEM BELOW)

	A great deal	Fair amount	Just a little	Not at all	No opinion
a. The energy shortage?	54%	31%	10%	4%	-
b. Air pollution?	18	33	24	22	1
c. Unnecessary noise in your area?	8	15	25	52	1
d. OMITTED					
e. OMITTED					
f. Inflation?	83	11	3	1	2

No obs.

21. OMITTED

23. Now, I'd like to ask you about some specific aspects of the environment. If you aren't sure about some of the things I am going to mention please don't hesitate to say so. First, which do you think, factories, automobiles or incinerators, is the major cause of air pollution in this country?

Factories.....	39%
Automobiles.....	45
Incinerators.....	
Not sure.....	9

24. Nuclear power plants are built near bodies of water. Do you think that's because the water is used as another source of power, as a disposal place for waste, or is used for cooling purposes?

Another source of power.....	11%
A disposal place for waste.....	16
For cooling purposes.....	52
Not sure.....	21

25. Do you think cancer can be caused in rats by every chemical, by most chemicals, or only some chemicals if they are fed to rats in a large enough dose?

Every chemical.....	14%
Most chemicals.....	31
Only some chemicals.....	42
Not sure.....	12

26. From what you have heard or read, do you think we produce enough oil in this country to meet our present energy needs or do we have to import some oil from other countries?

Produce enough oil.....	29
Have to import some oil.....	63
Not sure.....	7

27. Do you think that it is possible for a nuclear power plant to explode and cause a mushroom-shaped cloud like the one at Hiroshima or don't you think that is possible?

Possible.....	52
Not possible.....	31
Not sure.....	16

5a

. I'm going to read you a short list of topics and incidents that have been mentioned in the news media over the past year or so. As I mention each, if you happen to have heard or read about it, would you please tell me what it refers to? (ASK ABOUT EACH ITEM)

a. Love Canal, near Niagara Falls, New York: can you tell me what happened there? (DO NOT READ LIST)

CORRECT:	abandoned hazardous waste dump; chemical or toxic waste dump; place where chemical wastes have harmed people or made them move; where drums of toxic chemicals have leaked into the soil	22%	62/
PARTIALLY CORRECT:	people moved out of their homes; place where there was a problem with the soil. NO REFERENCE TO CHEMICALS	4	
INCORRECT		8	
Not sure		65	

b. The accident at Three Mile Island: can you tell me what happened there? (DO NOT LIST)

CORRECT:	nuclear reactor accident; Harrisburg incident; accident that almost caused a meltdown	14	63/
PARTIALLY CORRECT:	Presidential Commission; in Pennsylvania NO REFERENCE TO NUCLEAR POWER	3	
INCORRECT		4	
Not sure		19	

c. Synfuels or syntnetic fuels: can you tell me what they are? (DO NOT READ LIST)

CORRECT:	gas or oil made from coal or oil shale or tar sands; coal gasification; coal liquidification or coal liquids	3	22/
PARTIALLY CORRECT:	President Carter's new billion dollar plan; new source of energy recently proposed by President Carter and debated in Congress	3	
INCORRECT		15	
Not sure		12	

d. Acid rain: can you tell me what this is? (DO NOT READ LIST)

CORRECT:	polluted rain that harms lakes by disturbing the growth of plants, algae and fish; rain that is like vinegar; air pollution in the rain that harms land and water; sulphur dioxide in the air	26	65/
PARTIALLY CORRECT:	references to "rain" that do <u>not</u> include mention of air pollution	6	
INCORRECT		9	
Not sure		33	

29. Now I'd like to ask you some questions about air pollution. How serious do you feel air pollution is in this country--very serious, somewhat serious or not serious at all?

Very serious.....	35%	Not serious at all.	8%	86
Somewhat serious..	35	No opinion.....	2	

30. How about in this area: how serious do you think air pollution is here?

Very serious.....	11	Not serious at all.	48	67
Somewhat serious...	39	No opinion.....	2	

31. As you may know, many of the nation's marsh and swamp areas have had water drained out of them so that the land can be used for residential areas, factories or farming. Some people say we should drain more of these areas because land for development is becoming harder to find. Other people say that these marsh and swamp areas should be kept as they are because they help maintain nature's balance by providing breeding areas for fish and feeding places for ducks among other things. Who do you agree with most--those who feel these swamp and marsh areas should continue to be drained, or those who feel they should be preserved in their natural state, or don't you have a strong feeling one way or the other?

Continue to drain.	10	No strong feeling..	11	68
Preservie in natural state.....	65	Depends (vol.).....	8	
		No opinion.....	6	

32. Finding new places to build new industrial and power plants is sometimes difficult these days. I'm going to mention five types of buildings or sites. Assuming that they would be built and operated according to government environmental and safety regulations, you might or might not feel strongly about living close to them. For each type of plant please tell me the closest such a plant could be built from your home before you would want to move to another place or to actively protest, or whether it wouldn't matter to you one way or another how close it was? (IF DISTANCE GIVEN, GET DISTANCE IN MILES)

a. First, what about a ten-story office building?
mean=5.3 miles

Less than 1 mile..... 69/70

1 or more miles_____
(write in number)

Wouldn't matter one way or other.

Don't want it at any distance (vol.).....

No opinion.....

b. A power plant that uses coal for fuel?
mean=20.5 miles

Less than 1 mile..... 71/72

1 or more miles_____
(write in number)

Wouldn't matter one way or other.

Don't want it at any distance (vol.).....

No opinion.....

c. A nuclear power plant?
mean=91.0 miles

Less than 1 mile..... 73/74

1 or more miles_____
(write in number)

Wouldn't matter one way or other.

Don't want it at any distance (vol.).....

No opinion.....

d. A large industrial plant or factory?
mean=13.9 miles

Less than 1 mile..... 75/76

1 or more miles_____
(write in number)

Wouldn't matter one way or other.

Don't want it at any distance (vol.).....

No opinion.....

e. How about a disposal site for hazardous waste chemicals if the government said disposal could be done safely and that the site would be inspected regularly for possible problems?
mean=31.7 miles

Less than 1 mile..... 77/78

1 or more miles_____
(write in number)

Wouldn't matter one way or other.

Don't want it at any distance (vol.).....

No opinion.....

Would you please tell me approximately how far away the following are from your home?

a. The nearest freshwater lake? mean=18.8 miles

Less than 1 mile..... 6/7

1 or more miles _____ (write in number)

No opinion.....

b. The nearest river large enough for boating? mean=23.3 miles

Less than 1 mile..... 8/9

1 or more miles _____ (write in number)

No opinion.....

c. The nearest industrial plant or power plant? mean=7.9 miles

Less than 1 mile..... 10/11

1 or more miles _____ (write in number)

No opinion..... 14%

d. The nearest nuclear power plant that is either operating now or under construction? mean=90.8 miles

Less than 1 mile..... 12/13

1 or more miles _____ (write in number)

No opinion..... 32%

I am going to read you three points of view regarding pollution control. Please tell me which one best represents your opinion.

READ:

Protecting the environment is so important that requirements and standards cannot be too high, and continuing improvement must be made regardless of cost..... 42% 14/

OR

We have made enough progress on cleaning up the environment that we should now concentrate on holding down costs rather than requiring stricter controls..... 34%

OR

Pollution control requirements and standards have gone too far; they already cost more than they are worth..... 15%

Depends (vol.)..... 5%

No opinion..... 5%

35. [illegible] can [illegible] to improve the quality of our environment will cost money. There are two choices to pay for the cost of cleaning up the environment. The choice is to pay higher prices for those products that will cost more to make if we want to stop pollution. The other choice is to pay higher taxes to have enough money available for pollution control. Given these two choices, would you prefer to pay higher prices or pay higher taxes?

Higher prices..... 42% 15/

Higher taxes..... 17

Neither (vol.)..... 24

Both (vol.)..... 1

Depends (vol.)..... -

No opinion..... 6

36. I am going to read you three statements about environmental protection and economic growth. Please listen carefully and tell me which statement you agree with the most.

READ:

We can achieve our **current goals** of environmental protection and economic growth at the same time..... 39% 16/

OR

We must relax environmental standards in order to achieve economic growth.. 29

OR

We must accept a slower rate of economic growth in order to protect the environment..... 27

Depends (vol.)..... 1

No opinion..... 9

No cols. 17-23

. I am going to describe four different kinds of chemic[illegible]ich studies have shown to cause cancer in some people. I would like you to tell me which one of the [illegible]aches listed on this card you think the Federal Government should take for each chemical. (HAND RESPONDENT CARD) The first approach is that the government should ban certain uses of the chemical. The second is that the government should require clear warning labels on all products using the chemical but let them continue to be sold. The third approach is that the government should not regulate the chemical at all. (READ EACH ITEM)

	Ban	Warning label	NOT regulate	No opinion	
a. The first kind of chemical that has been shown to cause cancer is one commonly used to preserve food like bacon. Which one approach should the government take? (PROBE: That is, chemicals like nitrites).....	33%	57%	5%	5%	1%
b. The second is a chemical used as an ingredient in some hair dyes.....	31	60	3	6	1%
c. The third is saccharin.....	16	66	12	-	1%
d. The fourth is a chemical used to color food like hot dogs, soft drinks and ice cream. (PROBE: that is, Red Dye #2).....	4	44	1	5	2%

38. Even though human beings may not be directly affected, there are various risks that some chemicals pose to the environment. I am going to describe some of these risks and ask you what action, if any, you think the government should take. (HAND RESPONDENT CARD) (READ EACH ITEM)

a. First, the disposal of hazardous chemical wastes far out in the ocean where they harm the ocean environment where they are disposed. Do you think the government should prohibit the disposal, impose controls but not prohibit it, urge corporations to follow certain procedures but not require it, or not take any action at all?

	38a. Disposal in ocean (Col.21)	b. Chemicals in pesticides (Col.22)	c. Disposal in rivers (Col.23)
Should prohibit.....	57%	36%	[illegible]%
Impose controls but not prohibit it....	29	52	21
Urge corporations to follow certain procedures but not require it.....	6	6	5
Not take any action at all.....	2	1	1
No opinion.....	-	4	3

b. What about the use of chemicals such as certain pesticides which increase crop production but which kill wildlife. Again, looking at the card, what action, if any, do you think the government should take? (RECORD ABOVE)

c. And, the current practice of releasing into rivers certain industrial chemicals which have been shown t harm some fish. What action, if any, do you think the government should take? (RECORD ABOVE)

X 39. Each year industry introduces thousands of new chemicals into the marketplace. Some people think that companies should be required to submit information to the government before any of the new chemicals can be used and that the government should require tests of those chemicals which it believes may be dangerous to the public. Other people feel that government screening of all new chemicals would be expensive, might keep potentially useful chemicals off the market and that it is enough for the government to take action after a chemical has been shown to cause a problem. How do you feel--should the government (1) wait until a chemical already in use has been shown to present a problem before taking action or (2) conduct an extensive screening program to try to make sure all chemicals are safe before they are used?

Wait until there is a problem...	8%	24/
Conduct screening programs before chemical is used.....	85	
Depends (vol.).....	1	
No opinion.....	4	

40. Here is a list of several ways to get energy. (HAND RESPONDENT CARD) Looking ahead to the year 2000, and this nation's energy needs, which two or three of these sources of energy do you think we should concentrate on the most?

READ WHILE RESPONDENT LOOKS AT CARD:

This list includes coal; nuclear energy; energy conservation steps such as more and better home insulation and cars that get good mileage; water power from dams or waterfalls; solar energy including energy from the sun and the wind; oil and natural gas; and synfuels which are a new kind of fuel made by industrial plants which convert oil shale into oil or coal to a liquid or gas. Which two or three do you think we should concentrate on the most?

	40. Concentrate on most (Col.25)	41. Spend least effort (Col.26)
Coal.....	36%	9%
Nuclear energy.....	25	33
Energy conservation.....	35	3
Water power.....	31	10
Solar energy.....	61	6
Oil and natural gas.....	23	9
Synfuels.....	26	9
None.....	-	5
No opinion.....	2	15

41. Now, looking at the card again, which one of these would be the least effective way to deal with the

42. At the present time the United States has [illegible] in operation, [illegible] are currently under construction. I am going to read [illegible] statements about the use of [illegible] in the United States. With which statement do you most agree

READ:

We should continue to build more nuclear power plants as needed.....	23%	27/
No more new plants should be planned but we should continue to use the ones already in operation and finish those now under construction.....	47	
We should stop building nuclear plants including those under construction and shut down the existing ones as soon as possible.....	20	
Uncertain.....	9	
No answer.....	2	

43. Solar energy is a very broad term that includes many ways of using the sun to produce energy. Here is a list of ways that can be used by individual home owners to produce energy from the sun. (HAND RESPONDENT CARD) Please tell me which you have heard or read about and which you haven't.

	Have heard about	Have NOT heard about	
a. Solar panels to heat water for homes.....	79%		26/
b. Solar panels to heat space in homes	78		29/
c. Wood stoves to heat space in homes.	90		30/
d. Solar swimming pool, hot tub or spa heaters.....	68		31/
e. Solar cells to produce electricity.	65		32/
f. Small windmills to produce electricity.....	67		33/
g. Using farm wastes to produce gas for fuel.....	68		34/
h. Passive solar design such as having houses face towards the south; using walls, floors, ceilings or water containers for heat storage; using skylights for heat, t[illegible].....	71		35