BENEFITS FROM IMPROVEMENTS
IN
CHESAPEAKE BAY WATER QUALITY

Volume III

of

BENEFIT ANALYSIS USING
INDIRECT OR IMPUTED MARKET METHODS

(Budget Period II).

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Volume *II I*

of

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(Budget Period II)

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Forward

This is the second of two reports constituting the final report for budget period II of Cooperative Agreement #811043-01-0, which was initiated and supported by the Environmental Protection Agency. From the beginning, this cooperative agreement haa dealt with improving methods of measuring the benefits of environmental improvements. Budget period I of the agreement produced two documents which considered theoretical, conceptual and methodological issues involved. in using hedonic models (Vol. I) and recreational demand models (Vol. 11) evaluating environmental improvements.

The second budget period's work has extended the work of the first, especially in the area of recreational demand models. Volume I of budget period II's final report looks at the theoretical issues of measuring the benefits of quality changes, the conceptual issues surrounding perceptions of water quality and methodological issues related to estimating models with sample selection problems.

The report which follows is the second part of budget period II's final report. This report provides information on the recreational activities which take place on the Bay, as well as the monetary values people place on these activities. While not commissioned with the intent of helping in the process of revising the Bay plans, we hope that the discussions in this report will do just that.

Executive Summary

For more than ten years, the Chesapeake Bay has been the focus of an impressive amount of research and an array of environmental programs. The Chesapeake Bay Program, a cooperative effort by the federal government, Maryland, Virginia, Pennsylvania, and the District of Columbia, represents a coordinated commitment to enhancement of the water quality of the Chesapeake Bay.

Large commitments of money have been made to clean up the Chesapeake Bay. Yet there is little understanding of the nature and extent of the benefits which are derived from these massive commitments. Raising this issue does not imply that either the programs are misguided or need to be justified on some benefit-cost criterion, for many believe that the cleanup process is an expression of a fundamental morality that despoiling our surroundings is wrong. But understanding more precisely how *people* benefit from cleaner water in the Bay can help in allocating resources to clean up the water, for funds must be allocated temporally, spatially and functionally. Perhaps knowledge about the benefits from water quality improvements can help with those decisions.

Even though the returns from the Program derive from human benefits--human use and human health--the specific objectives and implementation strategies are designed to affect chemical and biological characteristics of the Bay. The connection between human benefits on the one hand and reductions of nutrients and toxic materials" on the other remains implicit. Perhaps the clearest link is between human use and fisheries and wildlife management. Here the vehicle for linking the strategy and the goal is at least understandable, even if the details of this linkage remain indistinct. In other cases, however, we are left confused as to how the policies impact on humans and how we would *ever* measure the success of these policies in terms *of* their achievements.

Thie report attempts to focus attention on the human use of the Chesapeake Bay. It describes something about the nature and level of that use. It also considers what we know and what we do not know about the relationship between chemical and biological characteristics of the Bay and human use. This relationship must be understood in order to address the more complex measurement of human benefits.

One objective *of* the report is to provide estimates *of* Values *of* Chesapeake Bay recreational activities and willingness-to-pay estimates of improvements in water quality associated with these activities. Available data has been used together with what is known about estimating environmental benefits. While Chapters 3, 4, 5 and 6 reflect our beat efforts at this task, it should be kept in mind that benefit estimates have an elusive nature. A number of different studies have been assembled, and an array of methods and specifications has been used to provide as much information as is currently available on the topic.

The benefit estimates themselves do not represent this report's most important contribution, however. We seek to describe, model and to some extent explain recreational uses of the Chesapeake. We may have serious doubts about the precision of willingness-h-pay estimates, but we still learned a great deal about the factors which matter to people in using the Bay, the obstacles to their increased enjoyment of the" Bay and the distributional implications of improving the Bay.

Specific information contained in this report includes:

- Maryland boaters, beach users and sportfishermen alter their behavior in response to poor water quality, as scientifically measured.

- Demographic factors, such es income and location of residence, influence observed use of the Bay.

- Cent ingent valuation experiments (hypothetical responses) reveal an " annual willingness to pay in increased taxes of over $100 million for improvements in Chesapeake Bay water quality.

- Observed behavior of Maryland western shore beach users reveal an annual willingness to pay for 20 percent improvements in water quality of between $2 million and $26 million.

- Many of the gains from water quality improvement are concentrated in the area of heaviest use around Annapolis, Maryland.

The estimates give magnitudes for the annual benefits to residents of the Baltimore-Waehington area of improving water quality in the Bay in the range of from $10 million to over $100 million. There are numerous sources of error and random elements in these estimates, and several activities and populations have been omitted. But based on these numbers, it seems plausible to estimate that the annual returns to cleaning up the Chesapeake are at least of this order of magnitude.

The long-run annual benefits will be higher than these estimates, however. Firat, as people learn that the Bay has become cleaner, they will adjust their preferences toward Bay recreation. This is especially true of people who do not currently use the Bay and are largely excluded from the analysis. Second, the population and income of the area have grown since 1984, and both are likely to grow more, increasing the demand for and value of improvements in water quality. Finally, we have ignored the value (both use and existence value) which households outaide the Baltimore-Washington area may have for the Bay. The Chesapeake Bay is a nationally prominent resource. Its improved health is of value to many who will never use it.

In conclusion, we hope this volume will provide a stimulus to decision makers to refocus attention on human uses of the Bay. Human uses and the protection of human health have always been the central theme of clean water legislation, but because of difficulties in relating these to specific standards, they have often dropped from sight in the formation of the actual programs. We hope to shed some light on ways in which Bay cleanup policies might be related to the behavior and preferences of actual and potential users of the Bay.

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Chapter 1

Environmental Programs for the Chesapeake Bay

Over the past ten years, the Chesapeake Bay has been the focus of an impressive amount of research and the beneficiary of a great many environmental programs. Concentrated efforts began in 1976 when the Congress directed the U. S. Environmental Protection Agency to conduct a five-year study of the Bay's resources and water quality. The study, which focused on three major problems of the Bay--nutrient overenrichment, toxic substances? and the decline of submerged aquatic vegetation--prompted action. In 1983 the three surrounding states, the District of Columbia, and the federal government signed a pact, the Chesapeake Bay Agreement of 1983, committing them to improve and protect water quality of the Chesapeake Bay through coordinated environmental enhancement activities. In late 1987 a new agreement was signed.

The State of the Bay's Water Quality

Concern over the Chesapeake Bay stems from declines in direct and indirect measures of the quality of the Bay's waters. The most apparent measures are related to the productivity of the Bay. Reduction in fish landings, combined with an awareness of the increasing loads of pollutants and their consequences, led scientists to assess the Bay's water quality.

The use of the term "quality" in assessing the Bay connotes a set of standards goals, or ideals with which the current conditions of the Bay can be compared. The quality of the water depends on one's standards, and the relevant standards depend on intended uses and frame of reference. For example, if the most desired use of the water were for transportation, then the Bay's current water quality would be quite satisfactory. At the other extreme, if one's standards are derived relative to the state of the Chesapeake Bay three centuries ago, its current quality is clearly too low.

Since the thrust of the Chesapeake Bay program cornea from observed declines in ecosystem productivity, it is useful to summarize the nature of those declines. Summary measures give the status of the Bay as a whole, but mask considerable differences in quality between the upper and lower Bay and among the various river systems and inlets of the Bay. The following measures suggest the nature of the thinking that led to the conclusion that the Chesapeake Bay waa declining in quality.

There are two kinds of evidence of the historical decline in the Bay's water quality. First there are scientific measures which are indicators of impairment of the Bay as a functioning ecosystem. A common measure of water quality is the level of dissolved oxygen in the water. This is oxygen available to various plant and animal life. Its absence can eliminte higher forms of life from ecosystems. Studies have shown that the extent of water with little or no dissolved oxygen has increased by 15-fold in the last 30 years.

Another indicator of water quality is the level of nutrients (nitrogen and phosphorus, mainly). These nutrients, while not harmful per se, enhance algal growth, whose decay increases the demand for oxygen. The increase of nutrients in the Bay's waters is an indirect consequence of population growth, changing technology and industrial and agricultural expansion in the area.

The decline in submerged aquatic vegetation (SAV) is another indicator of the decline in the Bay's water quality. The decline in SAV is connected with turbidity and growth of epiphytes and phytoplankton, by excessive nutrification. The loss of SAV means less suitable habitat for spawning finfish and shellfish. There are of course many other indirect measures of the declining health of the Bay. They all reinforce the notion that human factors are destroying the traditional ecological linkages of the Bay.

There are other signs of declining water quality more cogent to the lay public. Landings of well-known anadromous species such as rockfish and shad have dropped precipitously in the past several decades. Oyster harvest and oyster reproduction have also declined in the past decade. There is some ambiguity in the use of landings as a measure of water quality, of course. A considerable increase in effort devoted to harvesting fish has happened to coincide with the increase of effluents over time. Further, natural phenomena such as hurricane Agnes (1972) induce cyclical variations in finfish and shellfish reproduction. Nevertheless, there can be little doubt that the quality of the Chesapeake Bay's waters has declined, both in terms of the ecological health of the estuary and the benefits to humans of its use.

The Current Environmental Programs

The foundation of the Chesapeake Bay Program is the Clean Water Act, the ongoing federal environmental legislation dealing with water. Under the Clean Water Act, appropriations have been made available annually to the Chesapeake Bay Program, providing both its operating budget and its grant funds. The relationship between the federal legislation and Chesapeake Bay activities goes beyond funding, of course, since the Clean Water Act establishes the guidelines by which states then set specific water quality standards. The <u>Water Quality Standards Handbook</u> is the most recent document which contains the guidelines prepared by EPA to assist states in implementing 1983 revisions of the water quality regulations.

The Handbook defines acceptable approaches by which water quality baaed effluent limitations may be determined. Whether the pollutant specific or biomonitoring approach is taken, however, states must adopt criteria which are sufficient to protect the "designated uses" of a water body. Determination of designted uses requires an "attainability analysis," i.e. physical, chemical and biological studies to identify the suitable potential uses of the water and to determine whether these uses have been impaired. There is, throughout, a clear sense of the central position which human use activities should play in the setting of standards and the overriding obligation states should feel toward the protection of human health where 'people are involved in recreational uses of aquatic resources.

The first plan of the Chesapeake Bay Commission waa the Chesapeake Bay Restoration and Protection Plan of September 1985. This is currently the central document describing the goals of the Chesapeake Bay Program and the means by which these goals are being achieved. The general goals as stated in the plan are to

> "Improve and protect the water quality and living resources of the Chesapeake Bay estuarine system (in order) to restore and maintain the Bay's ecological integrity, productivity, and beneficial uses and to protect public health." [1]

The goals of the Restoration and Protection Plan are boad, and include both ecological and human health, as well as productive use by humans. By and large, however, there is no clear connection between the goals of the Bay Program which emphasize human health and human use and the means by which humans benefit from implementation.

To accomplish the broad goals, specific objectives and implementation strategies have been developed. Many of these strategies are designed to reduce or control nutrients. Major strategies to control point sources of nutrienta include plane to provide grants to design, construct, operate and maintain sewage treatment facilities, and plans to support phosphorous removal projects at treatment plants. Plans to support nitrogen removal at treatment plants have not been proposed, except for an experimental project conducted by the State of Maryland in the Patuxent estuary.

The primary stratagy established to control non-point sources of nutrients to the Bay has been to subsidize the implementation of "Best Management Practices" (BMPs) to reduce runoff from urban, forested, and in particular, agricultural lands. Maryland, Virginia, and Pennsylvania have instituted cost-sharing programs to promote agricultural BMPs. Among the agricultural BMPs supported through cost-sharing have been: strip cropping, buffer stripping, terrace and diversion construction, animal waste system installation, and reduced tillage planting. Some of these practices are employed to reduce sediment, pesticide, and herbicide runoff, as well as nutrient runoff. A secondary strategy to control non-point source pollution is to control urban runoff, in particular combined sewer overflows. Tactics to control combined sewer overflow include revamping of sewer systems and building holding ponds. The state of Maryland has also enacted legislation banning the use of phosphate detergents and controlling development along the Bay's shoreline.

The Chesapeake Bay Restoration and Protection Plan hae enacted a series of additional policies to reduce or control the level of toxic materials in the Bay, Among these policies are programs to support pretreatment plans to reduce the discharge of metals and organics from sewage treatment plants resulting from industrial sources, to fund dechlorination processes to reduce chlorine discharges into critical finfish and shellfish areas, and to implement oil spill response plans.

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[1] Chesapeake Executive Council, Chesapeake Bay Restoration and Protection Plan U. S. Environmental Protection Agency, Sept. 1985.

Lastly, the Chesapeake Bay Restoration and Protection plan has instituted a series of policies designed directly to "provide for the restoration and protection of living resources and their habitats and ecological relationships"[2] in the Chesapeake. Among these policies were programs to develop comprehensive fisheries management plans, expand oyster repletion activities, improve waterfowl and wildlife habitat, and re-establish submerged aquatic vegetation.

There is no "clear connection between the implementation strategies mentioned above and the goals of the Chesapeake Bay Program. The goals of the program are couched in terms of human benefits--human health and human use--but the specific objectives and implementation strategies are designed to affect chemical and biological characteristics of the Bay. The connection between human benefits on the one hand and reductions of nutrients and toxic materials on the other remains implicit, unsubstantiated and unarticulated. Perhaps the clearest connection is between human use and fisheries and wildlife management. Here the vehicle for linking the strategy and the goal is at least understandable? *even if* the details of this linkage remain indistinct. In other cases, however, we are left confused as to how the policies impact on humans and how we would ever measure the success of these policies in terms of their achievement of the Program's goals. In implementation, the focus on human use seems to have been lost.

The Role of This Report

This report attempts to focus attention on the human use of the Chesapeake Bay. The report describes something about the nature and level of that use. It also considers what we know and what we do not know about the relationship between chemical and biological characteristic of the Bay and human use. This relationship must be understood in order to grapple with the more complex measurement of human benefits.

Large commitments of money have been made to clean up the Chesapeake Bay. Yet there is little understanding of the nature and extent of the benefits which are derived from these massive commitments. How do people gain from the cleanup? Asking this question does not imply that either the programs are misguided or need to be justified on some benefit-cost criterion, for many believe that the cleanup process is an expression of a fundamental morality that despoiling our surroundings is wrong. Whataver the motivation for environment. al improvement, we believe that understanding more precisely how people benefit from cleaner water in the Bay can help in allocating resources to clean up the water. Moral imperative are of limited usefulness in the tactics of cleaning up the Bay, Even with commitments for a cleanup of the Bay, one must allocate those funds temporally, spatially and functionally. Perhaps knowledge about the benefits from water quality improvements can help with those decisions.

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[2] Chesapeake Bay Restoration and Protection Plan, Chapter 2, *page* 1,

One of our objectives is to provide some initial estimates of values of Chesapeake Bay recreational activities and willingness-to-pay estimates of improvements in water quality associated with these activities. We have used available data together with what we know about estimating environmental benefits (see Bockstael, Hanemann and Strand, 1985; and McConnell, Bockstael and Strand, 1987) to determine these "ball park" willingness-b-pay figures. While Chapters 3, 4, 5 and 6 reflect our best efforts at this task, it should be kept in mind that benefit estimates have an elusive nature. Much has been written about the imprecision of non-market benefit estimation, and we will have more to say on the question in this report. The usual difficulties are compounded by generally sketchy data. No new surveys were conducted for this study, and only one of the surveys used in the subsequent chapters was designed with benefit estimation in mind. Nonetheless we have put together a number of different studies and have used an array of methods and specifications to provide as much information as is currently available on the topic. We provide estimates of aggregate benefits for a variety of recreational activities. We have also tried to provide information on the relative magnitudes of benefits which are likely to accrue to different groups of users and to improvements in different geographical areas.

The benefit estimates themselves do not represent this report's most important contributions however. We seek to describe, model and to some extent explain recreational uses of the Chesapeake. The report represents an attempt to begin to understand the preferences and behavior of individuals toward the Bay. Models of behavior are essential to benefit estimation. Even in the face of huge uncertainty over benefit estimates, the underlying behavioral models can provide useful and reliable information. We may have serious doubts about the precision of willingness-to-pay estimates, but we can still learn a great deal about the factors which matter to people in using the Bay, the obstacles to their increased enjoyment of the Bay and the distributional implications of improving the Bay.

The Restoration and Protection Plan is an interim plan, "the first iteration of the planning effort implemented in response to this commitment." As such it is a first move in the direction of Chesapeake Bay improvements but it is subject to revision and fine-tuning as goals of environmental improvement become clearer and information about problems, technology and costs becomes more sophisticated.

What we hope this volume will provide is a stimulus to decision makers to refocus attention on human uses of the Bay, as the goals and the strategies for achieving these goals are fine-tuned in the coming year. Human uses and the protection of human health have always been the central theme of clean water legislation, but because of difficulties in relating these to specific standards, they have often dropped from sight in the formation of the actual programs, We hope to shed some light on ways in which Bay cleanup policies might be related to the behavior and preferences of actual and potential users of the Bay.

This report on the Chesapeake Bay is part of a larger EPA Cooperative Agreement. The initial agreement dealt with improving methods of measuring the benefits of environmental improvement. and did not deal with the Chesapeake Bay. This report provides information on the recreational activities which take place on the Bay, as well as the monetary values people place on these activities. While not commissioned with the intent of helping in the process of revising the Bay plans, we hope that the discussions in this report will do just that.

Chapter 2

The Role of Human Use Activities in Defining Goals and Strategies for the Chesapeake Bay

According to the EPA's Water Quality Standards Handbook, "States must adopt water quality criteria sufficient to protect designated uses." In the process of developing standards, if water body assessments are called for, they must "characterize present uses, uses impaired or precluded, and the reasons why uses are impaired or precluded."

The definition of designated uses which must be protected remains a murky issue. Underlying much of the document is the implicit assumption that chemical, physical and biological parameters can be used to define uses. On the other hand there is some acknowledgement of the reality that human activity does not necessarily align itself 'with physical and chemical water properties:

> "The basis of this policy is that the States and EPA have an obligation to do as much as possible to protect the health of the public even though it may not make sense to encourage use of a stream for swimming or wading because of physical conditions. In certain instances, particularly urban areas, people will use whatever water bodies are available for recreation."

At the heart of the dilemma is the disparity between the goals which are couched in terms of human uses and the targets of policy actions which are callibrated in ambient pollution levels. There is no one-to-one mapping between human use and scientific measurement. Failure to come to terms with their relationship has lead to something of a schizophrenia about human activity and scientific measurement in the Water Quality Standards. This schizophrenia is not unlike that found in the recreational demand literature which typically seeks to value environmental amenities by relating behavior to changes in ambient pollution levels without explaining how people perceive pollution.

The connection between human activity and scientific measures of ambient water quality is further obscured by the considerable ambiguity one finds in both these discussions about the ways in which individuals gain from water quality improvements. In the EPA Water Quality Standards Handbook, we find repeatad reference to protecting "uses," i.e. recreational activities, and at the same time a sense of obligation to protect human health. One might argue that these two concepts are coincidental, that we are interested in the health of humans as they participate in recreational activities in the Bay. In terms of pollutants which the individual can see (or smell or learn about in some less direct way), an individual's criteria for using the Bay are likely to exceed those minimum standards required to avoid health risks. On the other hand, the individual is totally unaware of health risks stemming from pollutants which cannot be easily detected. Thus many recreation decisions are not directly guided by quality characteristics associated with health standards.

Whether modelling recreational decisions or developing standards, we face a dilemma when we try to link water quality and human behavior. The obvious way to measure water quality is through chemical and physical readings perhaps supplemented by assessments of the biological resources. But water quality improvement is undertaken to enhance society's welfare which is recognized as deriving, in large part, from human use. Does human use respond to the changes in the chemical and physical composition of the water which physical and biological sciences measure? Are factors which affect their health the sole factors which matter to people? Can people perceive changes in these measures?

These questions not only plague benefit measurement, they are central to environmental policy making. *If gods* are fundamentally human oriented and standards are scientifically based, then the disparity between the two must be resolved for environmental regulation to achieve its potential. In what follows we present evidence about the human side of the problem.

First we present descriptive information on the variation in household perceptions of the Bay based on two surveys. These survey results do not reveal anything about the formation of perceptions however. To gain some insight into this process, we use the focus group approach, The material discussed in an earlier volume *of* this report is summarized in this chapter, and insights from our focus group experience are offered which are specific to water quality in the Chesapeake. From these various sources, we draw some implications for environmental policy.

Systematic Evidence Of the Link Between Percept.ions and Behavior

Evidence on what people think *of* the water quality *of* the Chesapeake and how they behave toward the Bay comes from two surveys: an on-site survey of beach users and a telephone survey (Figure 2.1). Our telephone survey was conducted May 1, 1984 to September 1, 1984, Research Triangle Institute (RTI) collected data for the University of Maryland on recreational use and perceptions of the Chesapeake Bay using a random telephone survey. The telephone survey was planned and executed jointly with an on-site survey of beach users at western shore Chesapeake beaches. The 1,044 households with completed interviews were residents *of* the Baltimore and Washington SMSA's. Demographic, attitudinal and use data were obtained. Chapter 3 reports on the analysis of use patterns and activities derived from the telephone survey. It also provides estimates *of* willingness to pay for Bay improvements.

In this chapter the attitudinal information obtained from the telephone survey is examined. This survey allows inferences to be made about the impact of perceptions on decisions to use the Bay. It also facilitates expansion *of* sample patterns of behavior and perceptions to the population.

The phone survey provides information about broad perceptions of the Bay, but without details about regional variation in quality. Specific regional information comes from the user survey, which gathers data about patterns of use and perceptions for 408 users *of* twelve beaches on the western shore of the Chesapeake. The user survey is described in detail in Chapter 4 of this volume.

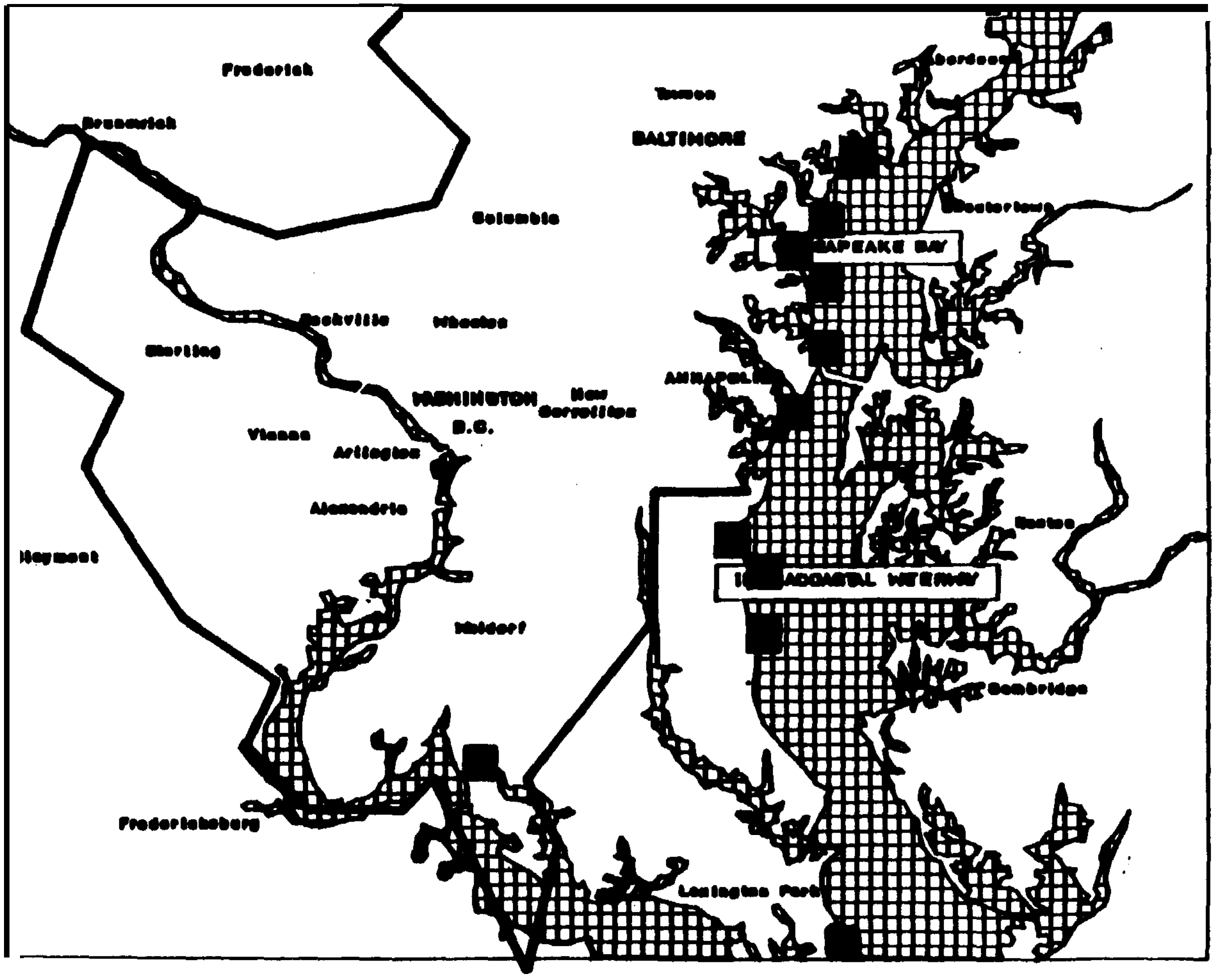


Figure 2.1

The Sampling Region for the Telephone Survey ( ) and the Beaches (●) Used in the Intercept Survey

Some General Attitudinal Patterns

Several important patterns emerged from the telephone sample. Forty-three percent of the households responded that they had used (31%) or intended to use (12%) the Chesapeake Bay for recreation in 1984. For the users, boating (73% of users), sightseeing (69%), beach use (66%)1, swimming (64%), and fishing (56%) were quite popular activities. Hunting (5%) and other uses (20%) were not as prevalent responses. The percent of the Bay users who visited eastern shore beaches (44%) was nearly the same as the percentage who visited western shore beaches (47%). Most of the users (81%) also visited ocean beaches in 1984.

Among those who did not use the Bay, reasons for non-use included:

Not interested in water-related recreation (40% of non-users)
Too busy to use (25%)
Takes too long to get there (20%)
Unable to use for health reasons (6%)
Water quality unacceptable (5%)
Costs too much (5%)
Too crowded (3%)
Too many jellyfish (3%)
Other (31%)

Personal preferences and the scarcity of households' leisure time were important considerations. Trip costs and poor water quality were not cited as often (5% of the time) but were still recognized as reasons.

The fact that only 5 percent of our telephone sample stated that the Chesapeake Bay water quality was responsible for their nonparticipation may diminish one's assessment of the role of water quality to Chesapeake citizens. For one thing, water quality in the Bay is not homogeneous--it varies substantially and respondents in our sample recognized the differences. Suppose respondents living in Annapolis believe Annapolis' water to be unsuitable for swimming but water at Pt. Lookout to be suitable. These individuals may respond that time was the prohibiting factor. It takes nearly three hours to travel from Annapolis to Pt. Lookout. From another perspective, people who do not visit the Bay because of time constraints may know little about the Bay's water quality and will not cite water quality as a problem.

A number of other questions were included in both surveys to learn more about perceptions of water quality. For example, we asked telephone respondents,

> "Do you consider the water quality in the Chesapeake to be acceptable or unacceptable for swimming and/or other water activities?"

Only 43 percent of the telephone respondents answered "acceptable," Alternatively stated, 57 percent of a random sample from the Baltimore and Washington SMSA's found the Bay water quality unacceptable for swimming and/or other water activities.

A similar question was asked in the user survey concerning specific western shore beaches with which the respondent was familiar. Even here there was negative reaction to the water quality, especially at certain beaches. We discovered, in fact, that some households found the Bay's water quality unacceptable? but nonetheless used it. There are several explanations for this apparent inconsistency, It is possible that households may find the water unacceptable for certain kinds of activities (swimming) but not for others (beach use or boating). Households may find the water quality acceptable for activities with short duration or during certain seasons of the year when the Bay appears cleaner. Finally, as mentioned earlier, the question abstracts entirely from the natural heterogeneity of the Bay. Some areas may be unacceptable to just about everyone while others may appear clean to the majority.

Some insight was provided by the user survey into the specific factors considered important in visiting a Chesapeake public beach. We asked individuals to rank each of five factors on a scale of one to five, with five being the most important to them. The weighted averages and medians were:

	Mean	Median
Presence of floating debris or oil	4.32	5
Presence of odors	3.44	4
Presence of jellyfish	3.41	3
Presence of cloudy water	1.97	2
Presence of seaweed and other aquatic plants	1.85	1

These numbers indicate that floating debris and oil is the major quality criterion, with odors and jellyfish being the next most important.

The question was re-analyzed by considering the differential responses of users who came into contact with the water (swimmers and waders) and those who did not (sunbathers, etc.). The contact users cited odor as the most important or the second most important criterion 56 percent of the time, whereas non-users cited it as highly important only 16 percent of the time. On the other hand, the presence of jellyfish was considered to rank as the first or second factor for the non-contact users 84 percent of the time but only 37 percent for individuals who were in contact with the water. These results are somewhat difficult to interpret because we cannot determine cause and effect. Logically, those moat bothered by jellyfish are likely to refrain from entering the water. However, those who go into the water are more likely than those who don't to detect unpleasant odors.

In any event, of the five factors deemed important and perceivable to beach users, three are characteristics which could be linked with water quality. It is interesting, for the purpose of keeping our perspective, that a natural factor (jellyfish) ranks among the unpleasant features of the Bay.

Two Propositions about Water Quality and Behavior

To investigate the relation between current water quality and the use of the Bay, we examined two simple propositions.

Proposition 1: The percentage of respondents at a particular beach who find the water quality unacceptable is related to water quality as measured by scientific water quality readings at the site.

Proposition 2: An individual's use *of* the Bay is related to his/her assessment of whether the water quality is acceptable.

Affirmation of Proposition. 1 implies a positive relationship between individual behavior and the objective measures of water quality upon which environmental policy is based. Proposition 2, if true, indicates that people are consistent in matching their behavior to their perceptions of water quality. Both propositions are important in making the connection between environmental improvements and behavior-based benefit measures.

The Bay is a well studied ecosystem and has been the focus of much attention by the U. S. Environmental Protection Agency and the states *of* Maryland and Virginia (e.g. U. S. EPA, 1983). Also, Maryland counties on the western shore sample water at the beaches on a monthly basis in compliance with Maryland health requirements. These various sources provide objective measures of water quality at the Chesapeake beaches, and allow examination of the relationship between users' perceptions and objective measures at the beaches visited.

As mentioned earlier, the user survey instrument contained a question asking respondents to judge whether specific beaches on the western shore were acceptable or unacceptable for swimming or other water related activities. To answer, the respondent was not required to have used the beach but only to be familiar with it. The water quality at Sandy Point State Park was familiar to the largest percentage of people (63 percent), whereas only *one* person knew about the water quality at Camp Merrick. The percentage of those familiar with a beach who found the water quality at that beach acceptable varied from 94 percent at Rocky Point State Park to 12 percent at a Baltimore Park, a beach used primarily by picnickers.

As a guide to the sample's responsiveness to water quality, the percentage of people not finding the water quality acceptable (PCNA) at a beach was regressed on the moot probable *fecal* coliform count (FCC) for that beach. The fecal coliform counts were collected at the beaches during the swimming season by county officials. Unfortunately, the FCC measurement was available for only nine of our twelve beaches.

One might argue that individuals would have no way of perceiving fecal coliform. However, a high FCC might manifest itself in odors or may be correlated with other factors which cause visible changes in the water. Of course, periodically high counts could cause a beach to be occasionally closed by the health officials, a practice that could "brand" the water quality at certain beaches. Since there were five examples of beach closures, the estimation of a relationship between PCNA and FCC should serve as a small test of the ability of individual to perceive factors correlated with FCC.

To assure that obvious restrictions on the PCNA and FCC variables were not violated by our functional forms a Weibull distribution was assumed:

$$PCNA = 1 - \exp[-(FCC/\delta)^{\bullet}], \quad (2.1)$$

where $\bullet$ is the shape parameter and δ is the scale parameter. Using a non-linear least squares routine, we obtained parameter estimates of 2,537 and .49 for δ and $\bullet$ respectively with ratios of parameter values to standard errors greater than two in both cases (see Table 2.1). These results support Proposition I. There is an apparent connection between objective measures of water quality at a beach and households' perceptions that water quality at the beach is acceptable.

Table 2.1
Parameter Estimates and Standard Errors
for Weibull Distribution

Coefficient	$\bullet$	δ
Estimate	.495	2,537.
Standard Error	.095	923.

The value of the shape parameter suggests that the percent of beach users who find water quality unacceptable is concave in the water quality variable. (A sufficient condition for concavity is $\bullet < 1$, $\delta > 0$.) To find the fecal coliform level for a given level of acceptance, equation (1) is inverted and estimated coefficients inserted

$$FCC = 2,537 \cdot (-\ln(PCNA))^{2.02}.$$

For an acceptance rate of 90 percent, the estimated maximum median fecal coliform count is in the order of 25 fecal coliform per 100 ml. At fecal coliform counts of 200, 75 percent of the users are estimated to accept the quality. At counts of 1,200, this estimated ratio drops to 50 percent.

The second proposition was tested using the telephone survey response. Households were asked whether anyone in their household had changed (stopped or started) swimming patterns in the Chesapeake because of water quality. Two hundred seven of the 1,044 telephone respondents stated they had stopped, and 26 stated they had started. Of those who stopped, 75 percent believed the water quality was unacceptable. In comparison, 53 percent of those who did not change thought the water quality was unacceptable. Finally, the water quality was believed unacceptable by 42 percent of those who started to swim.

We regressed the individual binary response as to whether or not they stopped swimming against their acceptance of the water quality. The following logistic probability model was estimated:

$$P = \{1 + \exp[\alpha_0 + \alpha_1 WQP]$$

where

$$P = \begin{cases} 0 & \text{if the household stopped using the Bay} \\ 1 & \text{if the household did not stop} \end{cases}$$

WQP = water quality percept ion (1 if acceptable, 0 otherwise)

A maximum likelihood estimation approach produced the effects reported in Table 2.2. Water quality perception appeared to have a positive statistically significant impact on whether the household continued swimming, indicating some relationship between users' perceptions *of* water quality and their use of the water. This result provides support for Proposition 2 that behavior is related to perceptions. Nonetheless, some people who consider water quality unacceptable are still observed to swim.

Table 2.2
Effect *of* Perceptions on Use

Effect	Estimate (a_i)	Standard Error
Intercept	1.54	.1?
Water Quality Perception	.57	.13

Sample Size = 503

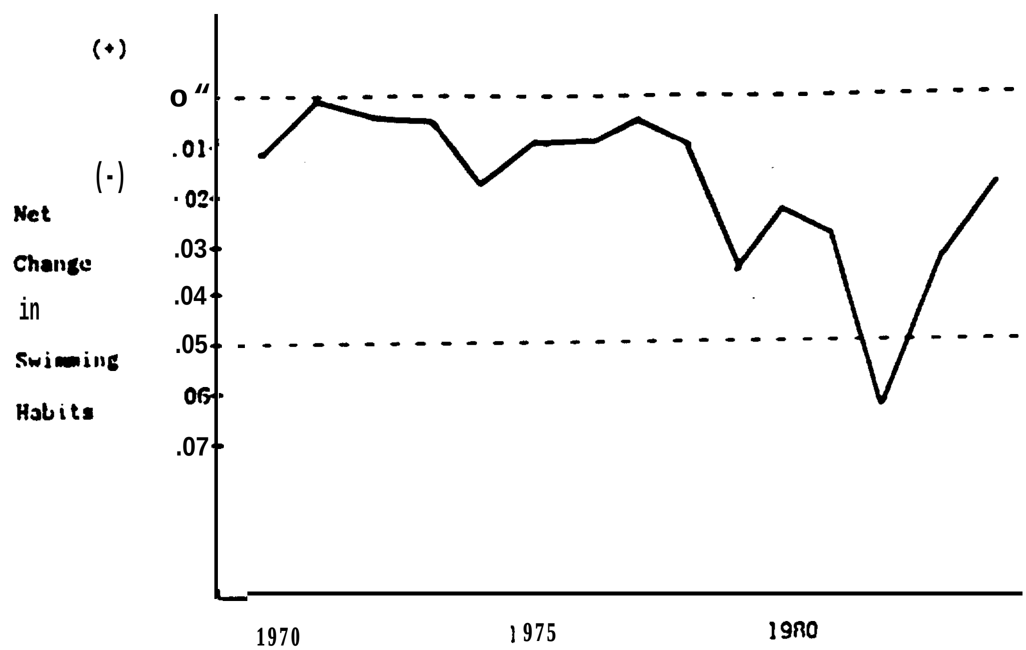
Additional insight into the first proposition can be gained from an analysis of temporal changes in household habits of using the Chesapeake. It is the consensus among scientists that the water quality of the Chesapeake fell substantially over the period 1950-1980 (EPA, 1983). The living resources of the Bay have been used as a primary indicator *of* this decline. Submerged aquatic vegetation and anadromous fish stocks are among those living resources whose dramatic decrease over this period has been cited. If we can show that contemporaneous with the decline in objective measures of water quality, individuals were more likely to quit using the Bay, we have additional indirect evidence of the link between behavior and water quality,

Responses from the telephone survey were used to develop a time series on the percentage of households who changed their swimming participation. The procedure was fairly complicated since the size of the population eligible to change its behavior varied from year to year. That is, consideration had to be made for how long the household had lived in the Chesapeake region and whether they had previously stopped swimming. For example, households responding that they stopped swimming in 1979 clearly were not eligible to stop again in 1982.

The time series is shown in Figure 2.2. Approximately one percent of the eligible households stopped swimming each year in the early 1970's. This increased to around *five* percent per year in the early 1980's. The trend is definitely one of increasing non-participation in swimming over the time in which it is believed that declines in water quality were occurring. Although the overall pattern is a diminishing one, there appears to be a possible modification of the trend near the end of the period.

Figure 2.2

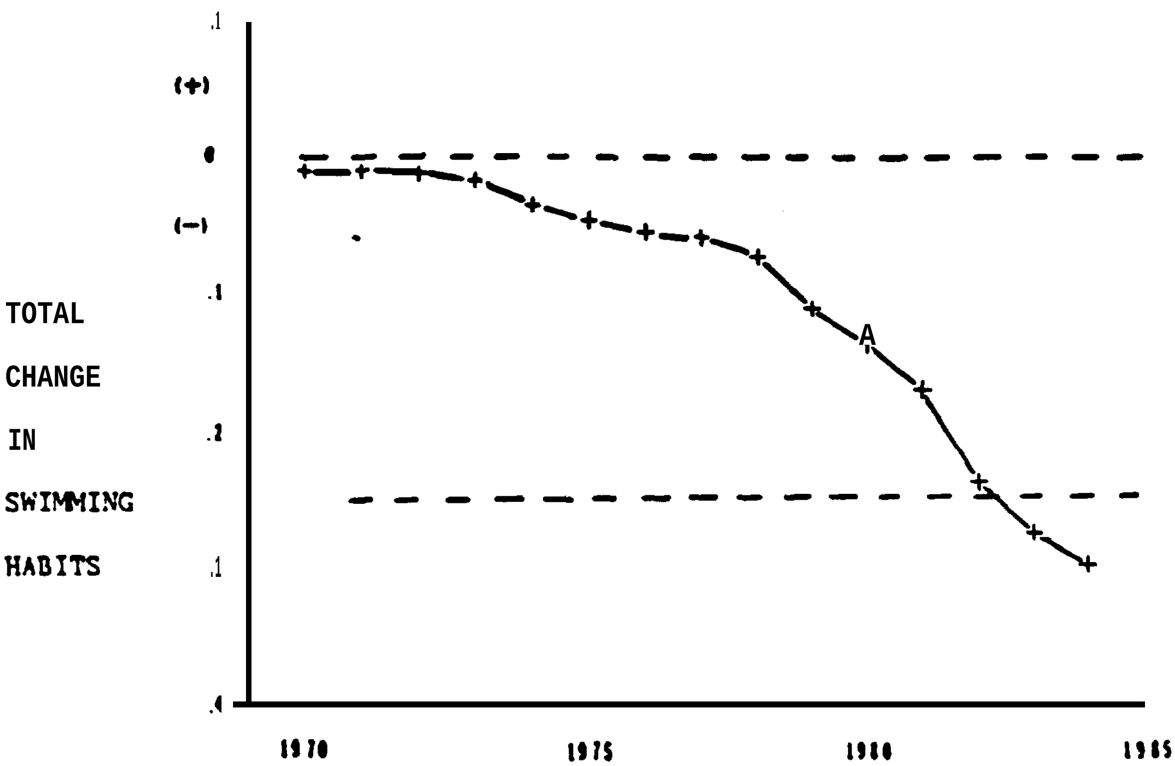
Annual Net Change in Swimming Habits
1970 -1984



If one is bold. enough to assume no reversals in habit for a particular household, the individual percentages can be combined to show the cumulative effect of water quality change on a given 1970 population Of households (Figure 2.3). With this assumption, 30 percent of households that had been in the area in 1970 would have had a ❑ember who ceased swimming by 1984.

Figure 2.3

Cumulative Net Change in Swimming Habits
for a Popu ation in Residence in 1970 and Remaining in Resdence until 1984



The decline is interesting for a number of reasons, but mostly because it shows the potential stock of individuals who could be enticed to return to the Bay if water quality were improved. Benefits from water quality improvements will derive *from* increased desirability of current recreational trips, more (of these higher quality) trips taken by current users, and finally trips taken by those who are currently non-users but are enticed into the activity by higher quality. The above analysis suggests that water quality improvements could, over a sufficiently long time, attract a large number of new (or returning) users. To the extent that demand analysis is based on current use and fails to predict accurately this potentially large number of new entrants, benefit estimates will be understated.

Results of Some Focus Group Experiences

The above evidence about the relationship among (a) use of the Bay, (b) subjective perceptions of the Bay's water quality, and (c) objective measures of specific attributes of water quality in the Bay suggests in general that changes in water quality have an effect on behavior. In subsequent chapters we show how economists can use information about changes - in behavior induced by quality changes to assess the economic gains from water quality improvement.

Good theory, convincing benefit measurements, and effective environmental policy do not require that individuals act knowingly and mechanically in response to changes in ambient quality. In fact, casual observations suggest that many people have only vague notions about environmental quality, and act unconsciously in response to changes in quality. However, much can be gained by understanding better the link between perceptions and behavioral changes. How are perceptions formed? Which aspects of water quality, objectively measured, matter most to people? These and other questions about the formation of perceptions require some insight into individual motives.

Traditional research methods have not been very helpful in obtaining these insights. In contrast, focus groups (Reynolds and Johnson; Caldor; Desvousges and Smith) have been found to be a useful means *of* investigating the existence and formation of subjective perceptions on environmental issues and marketing questions. Focus groups are group interviews conducted in the form of informal discussion sessions under the guidance *of* a neutral moderator. Participants are encouraged to talk at will and describe personal experiences, anecdotes, and acquired knowledge. The moderator merely encourage participation by all, mediates arguments and spurs conversation and thought through questions carefully designed to give direction to the discussion. By encouraging participants to reveal thought processes and levels *of* awareness, their motives begin to emerge.

For this study we conducted two focus groups *of* a quite different nature. The groups were made up of 10 to 15 individuals who had some common association with one another. Each session lasted about one and a half hours. In each group there were Chesapeake Bay users and nonusers; however, the groups were chosen so as to be heavily weighted towards people familiar with the Bay.

One focus group consisted of students at the University of Maryland in College Park, who were members of a wildlife conservation group. Many of these students had taken environmentally related courses. A number of these students had grown up in close proximity to the Chesapeake Bay, as active users of the Bay.

The second group consisted of residents of neighborhoods along the western shore of the Chesapeake in the vicinity of Plum Point, Maryland. Their participation was solicited through an announcement in a local newspaper. Many, although not all, of the individuals were retired, and all lived near the shore year round. Their backgrounds and education were quite varied.

These groups were polar in several respects. The college group was young, formally educated in many scientific and environmental matters, and tended to be active users of the Bay. The Plum Point group was older, often retired, not necessarily fluent in scientific and technical matters, and often somewhat passive in their use of the Bay. The groups shared the characteristics of having no small children and not being actively engaged in building careers.

In each case, the moderator presented a formal introduction indicating the general purpose of the gathering and the underlying research. The introduction was notably vague so as not to bias subsequent responses. For the remainder of the session the moderator rained questions but did not attempt to confine individuals' responses. All individual were asked to respond to moat of the questions so as to avoid dominance by one or two people.

Examples of the types of questions raised were the following:

> What does water quality mean to you?
> How do you know when the water quality is poor?
> What activities do you pursue on the Chesapeake?
> Has the water quality gotten worse over time?
> What do you think is the moat serious cause of pollution in the Bay?
> Is water quality different in different parts of the Bay?

Initially, we had several questions in mind which we hoped the focus groups could help us answer. These included the following:

1. What sources of information do people use in forming their perceptions of water quality in the Chesapeake Bay?

2. What factors affect their interpretation of this information (e.g. past experience, attitudes), i.e. what is their standard based upon?

3. In what way does the water quality of the Chesapeake affect people; i.e., in what sense do they lose when water quality deteriorates?

4. Do their perceptions affect their behavior and how quickly can behavior be expected to change in response to environment changes?

Our focus group results suggest the following answers to these questions.

Question 1.

Appearance was by far the most frequently mentioned signal of water quality deterioration. Whether or not the individual had been exposed to scientific information on the subject, he was most likely to report that how the water looked, felt and smelled were his most important indicators. Even individuals who *no* longer used the Bay or certain sections of the Bay based their decisions on the water's appearance during their last visit.

Without exception, individuals used clarity of the water as an indicator. The degree of transparent y of" the water was taken for granted to be a measure of quality. A few individuals, particularly those living on the Bay all year, noted seasonal differences in clarity, but still used this as their first quality indicator. Other factors which signalled poor water quality were the nature of the bottom, discoloration of the shoreline, froth on the water? floating debris (including man-made) and dead fish. Smell was a clear signal of poor water quality, but odors were not common, and visual appearance was used as a more discriminating indicator.

The second most common signal of pollution was "guilt by association." Individuals frequently stated that they deduced that water quality would be poor in sections close to activities which they reasoned would generate pollution. Such activities included sewage treatment plants, housing and industrial developments, marinas and other heavy concentrations *of* boats, and farms (particularly with livestock). These deductions took place in both groups but were *of* a slightly different nature. The college-age group was relatively more concerned with agricultural operation and with contamination from boat sewage. The older group seemed to consider development -- with or without sewage treatment -- of greatest concern. Some of this difference can be accounted for by the spatial location and familiarity of the two groups. The Plum Point group knew local conditions well but were relatively immobile and had limited experience with the rest of the Bay. In contrast, the college students were heavy boat users and therefore extremely mobile. They tended to have personal experience along large portions of the Bay and its tributaries. Graphic examples *of* manure pond overflows, run-off from pig farms, etc., were offered. Residents of the Plum Point area would have little exposure to agricultural runoffs more common to the upper Bay.

Television, radio and newspapers were the next most common external source *of* information. Rarely waa specific information about local Bay conditions gleaned from the media. Instead, these sources create a general awareness of environmental problems. In large part the inferences about activities which create pollution were baaed on information gathered from these secondary sources.

It was clear that at least some individuals were privy to more objective and scientific information than that available in the public media, although the distinction between types of information sources was not always made clear. Many of the college students had taken courses and subscribed to scientific journals. They were able to draw more sophisticated deductions about links between water quality and surrounding land uses. Also, these individuals tended to be distrustful of information obtained from the media.

The final signal of pollution also depended on deduction. Individuals noticed changes in the amount and diversity of wildlife in and around the Bay and concluded that these changes were the result of water quality changes. Specifically mentioned were crabs, turtles, and ducks. One individual associated a decline in the diversity of finfish species with water quality deterioration, Another individual argued that increases in fish prices were due to pollution.

Question 2.

Different individuals seemed to interpret similar information in different ways. Factors which affected their interpretation included their past experience and general attitudes. When individuals react to the appearance of something, they must, by definition, be comparing it to a standard. More often than not, the standard used by these groups was past experience, although occasionally individuals seemed to be operating with a less personal standard such as pictures of clean water in mountain lakes. Frequently individuals compared the appearance of the water to what they (accurately or not) remembered experiencing as a child. With the exception of one individual (of the older group), everyone remembered the Bay water being cleaner when they were children. This was true of the 18- and 19-year-olds as well as the 50- and 60-year-olds. When questioned, individuals admitted that both maturity and publicity had raised their level of consciousness about water quality but still insisted that water quality was poorer now than when they were children. Also, the college studenta noticed some improvement over the last few years -- in terms of fewer dead fish and birds, less heavy oil present, and the cleanup of dumps along the tributaries — although they thought the water was dirtier now than ten years ago.

Individuals' interpretationa of information were also clear] y affected by their general attitudes -- level of trust in political and entrepreneurial forces and confidence in technology. Among the college students, some indicated distrust for political processes and commercial enterprises to the extent that they believed everything was polluted, whether or not they could see it, These individuals stated that they would need hard scientific evidence to be convinced that improvements had been made. At the other extreme, notably in the older group, a few individuals indicated a trust in the scientific community, regulator y processes and technology, fueling that the populace would be protected from unsafe conditions through cleanup activities. Some indicated resignation to the trade-off between the environment and development. In all cases attitudes affected how individuals interpreted the same sensory and media information.

Question 3.

Individuals perceived themselves to be affected by water quality in a number of ways. It was clear from the discussions that both groups were apprehensive about going into water they perceived to be dirty. A distinction was made between wading and swimming, as many indicated that they did not dare submerge their heads in water they thought to be polluted. Also many wore shoes when wading to avoid contact with the bottom. While only a few actually mentioned bacteria and potential illness, most seemed to have health and safety factors in mind.

It is difficult to separate this apprehension from the general unpleasantness associated with unattractive water. No doubt we are conditioned to link clarity with cleanliness and cleanliness with health. Nonetheless, it seems that even if the individuals were convinced there were no health risks, they would consider themselves hurt by water quality deterioration. Many mentioned the unpleasant *feel of* the bottom and the sticky film that swimmers feel on their skin after bathing. Others mentioned that clear water allowed them activities such as seeing living organisms in the water, activities which were precluded by murky water. Still others who never entered the water but only walked along it reported the experience more pleasurable when the water looked cleaner. In fact, some gave up the activity when the water looked dirty.

What is interesting however is that no one mentioned toxics or heavy metals. Some were aware *of* the term nutrients, and most connected this with turbidity, algal blooms and slimy bottoms. Others emphasized oil spills. Particularly in the older group, individuals expected that pollution could be seen. Those individuals seemed most conscious of health risks, yet indicated they felt safe going swimming on days when the water looked clear. Few indicated apprehension about health *effects* from unseen pollutants.

Lasses also accrued to individuals through perceived reductions in angler and duck hunting success. Many complained of a decline in the quality of fishing, crabbing and duck hunting. Others complained of the reduced variety of finfish available in the Bay. Among the college students were some who professed a concern for the wildlife in situ. That is, some individuals indicated reduced enjoyment of non-consumptive wildlife uses.

Individuals also indicated a fear of eating fish and shellfish caught in polluted waters. For many individuals low catch rates were irrelevant because they did not dare eat fish caught in local waters.

Interestingly, one individual who did not use the Bay for any recreational activity indicated that he really did not care what happened to the water quality in the Chesapeake. His only concern was the quality *of* his drinking water. Here is a real world example *of* the concept of "weak complementarity." Weak complementarily is said to characterize an individual's preferences if he does not care about the quality of a resource that he does not use.

Question 4,

Earlier *in* this chapter, survey results were shown to support the empirical relation between behavior and perceptions. However, frequently inconsistent behavior was observed--some individuals perceived the water quality to be poor but continued to use it. The focus groups shed some light on these anomalies.

With only a few exceptions, the individuals in both focus groups were familiar with . the Bay and were recreational users of one sort or another. Also, with only a few exceptions, the individuals were deeply concerned about the water quality of the Bay. In most circumstances individuals had not given up all forms of recreational use, but they had reduced that use and curtailed some activities altogether,

We can model an individual's behavior as changing in three ways *in* response to perceived changes in water quality: he can alter the choice of whether to participate in an activity, he can alter the sites at which he recreates, and he can alter the frequency *of* recreation.

The two groups revealed different types *of* reactions to water quality deterioration. The younger, more mobile group stopped going to certain places which they perceived to be worse. The older, less mobile, group stopped participating in certain activities which they perceived to be sensitive to water quality, particularly swimming. They also curtailed their fish and crab catch to avoid eating contaminated fish. In both groups, there appeared to be a frequency dimension to individuals' reactions as well. Many who found the water quality too poor for swimming generally indicated they would go in on especially hot days or on days when the water looked especially clear. The latter suggests that the degree of intra-seasonal variation in pollution and other causes of turbidity will *affect* the frequency *of* participation in a recreational activity. Of course only those who live near the shore can assess the water clarity before incurring the coats of the recreational trip.

While there is no firm evidence for this, many individuals seemed to participate more in recreational activities than they believed wise. In many cases, it was because they had been participating in these activities for years and resisted giving them up and because they perceived no suitable alternative. In contrast, some individuals had curtailed certain activities because of bad experiences and indicated that it would take very convincing evidence to bring them back. All of this suggests that the response of behavior to perceptions may be significant but may also be a delayed response.

Summary of Focus Group Experience

In summary, we can construct a set of hypotheses about perception formation. The list would include

10 Individual associate the quality *of* the water with its appearance -- specifically its clarity and color.

2. Individuals associate the quality with the amount of floating (man-made) debris and dead organisms.

3. Individuals associate quality with angler success rates.

4. Individuala deduce quality from surrounding land and water uses.

5. Individuals infer things about the quality of water from general publicity about the environment and/or technology change.

6. Individuals learn specifics about quality from scientific publications, educational experiences.

The more exposure individuals had to information of the sort included in (5) and (6), the more likely were they to deduce things about water quality from surrounding activities. Nonetheless, items (1) and (2) in the above list dominated, irrespective of age, education, etc.

Individuals perceived themselves to be harmed by poor water quality through a number of routes:

1. The individual's recreational experience is degraded by unpleasant appearances floating debris, etc.

2. The individual fears health and safety risks.

3. The individual believes poor water quality reduces catch rates and variety of species.
4. The individual fears eating fish from areas with poor water quality.

It is worthy of note that both unpleasant appearance and poor fishing conditions harm individual but also serve M signals *of poor* water quality. These signals carry with them suspicions *of* further losses in the form of health risks from contact with the water or from eating contaminated fish.

Conclusions

In this chapter we set out to explore the relationship between human activities and the water quality of the Bay. This relationship is important for the Chesapeake Bay Program for several reasons. First, human use of the Bay is the ultimate goal of devoting resources to improving the quality *of* the Bay. Gaining some sense that people change their use of the Bay with changes in water quality suggests that Bay clean-up strategies can have significant value. Second, economists' benefit measures of improvements in water quality are based primarily on changes in behavior. Knowing that households have some sense *of* water quality and are affected by this sense *of* water quality when deciding how to allocate their scarce time and resources gives support to the methodology of benefit measurement.

We have explored the relationships between perceptions and human activities in two ways. From two surveys, a phone survey of households and an on-site survey of beach users, the relationship between objective measures of quality and perceptions of quality and behavior has been examined. The telephone survey supports the relationships in several ways. Households that perceive water quality as unacceptable are more likely to quit using the Bay. The telephone survey also shows an implicit but positive correlation between the likelihood *of* quitting and the Bay's water quality. The user survey also provided support for the perceptions link. This survey shows positive correlation between measures of fecal coliform at each of nine beaches and the proportion of households that found each beach unacceptable.

The focus groups provide insight into how people judge the quality of water and why they change their behavior in response to quality changes. A variety of sensible motives contribute to behavior changes. People smell, feel and see the water and its surroundings. They react when they learn about changes in water quality from newspapers television and other media.

Of particular importance to policy makers is the clear signal that individuals suffer from water quality deterioration in more than one way. Many regulation are implicitly based on health standards, yet health effects are only part of the story. Irrespective of health risks, individuals were uniformly adament in arguing that recreation in water perceived to be dirty is less enjoyable. This dimension is not totally independent of health concerns, however, since dirty water was additionally considered to be a signal for health risks. The word "risk" is a key one. Whether or not a given state of water quality does in fact present a health risk, the individual suffers from the uncertainty associated with not being able to assess the risk himself. While we do not go into this problem in great depth in this study, it is important to keep a few things in mind. Uncertainty is ceteris paribus undesirable, and there are two sources of uncertainty involved here. One is the uncertainty associated with not knowing what is in the water and whether it is potentially harmful. The second is the uncertainty associated with the actual onset of adverse health consequences if indeed the water was potentially harmful.

The losses described above pertain to water use that involves contact. There are still more ways in which individuals perceive themselves to be harmed by poor water quality. The enjoyment associated with any activity within sight of the Bay is claimed to be diminished if the water appears dirty. Finally, to the extent that poor water quality reduces fish abundance and species variability y, sportfishermen see themselves harmed. Finally, even if fish catches aren't reduced, perceived poor water quality suggests health risks associated with eating fish catch.

Together the -two sources of information provide support for the inferences which we draw in the following chapters. Individuals are aware of water quality, change their behavior in response to water quality changes, and derive benefits when the quality of the Bay is improved.

Chapter 3

Recreational Use of the Bay and Willingness to Pay Estimates for Improvement to the Bay se a Whole

A variety of methods have been used to analyze the welfare effects of water quality improvements. In the introduction to this chapter, a brief description of the two basic approaches is offered to prepare the reader for the methods used in this and following chapters. A more thorough examination of one of the methods? contingent market valuation? is offered in Cummings) Brookshire and Schulze. Bockstael, Hanemann and Strand supply a thorough examination of the other method, indirect market valuation,

The indirect market approach uses individual behavior in related markets to infer values *of* non-marketed goods. For the case in question, water quality, the researcher observes the demand for goods that are related to water quality, such as recreational tripe. The usefulness of the approach depends on the responsiveness of behavior toward water quality. If individuals value good water qualit y, the y will be drawn to goods or activities associated with high quality water end will be willing to travel farther and incur greater costs for this improved experience. Their behavior can be observed, and from this, values deduced. One drawback to this approach is that assumptions regarding behavior must be made in order to assess values. This results in untestable restrictions on behavior implicitly or explicitly imposed in the modelling process.

Contingent market analysis involves the establishment, in the interviewee's mind, of a fictitious or hypothetical market circumstance. The interviewee is asked to respond to the circumstance in a hypothetical manner. By establishing a scenario to explain the respondent's answers, the researcher is able to deduce characteristics of the respondents preferences.

The "average" willingness to pay or sell is the predominant value obtained in most contingent valuation exercises. A question or series of questions is designed to elicit the respondent[s] (hypothetical) bid *for or* against the policy in question. The approach can be directed very specifically to the good or quality change to be valued, and thus, in theory, elicit the amount of money needed to keep the individual at the same level of satisfaction before and after an event. The questions can be quite specific and may therefore define precisely the event or policy to be assessed. The disadvantage of the approach is its hypothetical nature. Rarely is it possible to test the validity *of* the response. through observations on behavior. In addition, the specific valuation problem may be so remote from the respondent's market valuation experiences as to leave him unable to respond reliably.

Contingent valuation has been deemed a useful technique (see Cummings, Brookshire and Schulze) provided it is applied to problems which are closely associated with common market valuation experiences. Car-son and Mitchell present evidence of stable contingent valuation estimates for national benefits of clean freshwater in the U. S.

It seems reasonable to attempt some contingent valuation for the Chesapeake Bay problem as long as caution is exercised in the interpretation of the results. For us, derivation of the contingent values thus obtained is not intended as an end unto itself, but rather information to support the results of additional analyses.

Recreational Use of the Bay

During the summer of 1984, a telephone survey of over 1,000 households in the Washington, D. C. and Baltimore Statistical Metropolitan Sample Areas (SMSA's) was conducted. A description of procedures can be found in Appendix A. Appendix B is a copy of the survey instrument. One objective of the survey was to provide a complete inventory of beach use by residents in the Baltimore/Washington SMSA's (see Figure 2.1), which include the District of Columbia, several counties and incorporated cities in Northern Virginia and much of central and southern Maryland. Restricting the geographical area in this way biases the sample of individuals toward urban residents. However, this area includes a large percentage of the population surrounding the Bay.

In the subsequent discussion, the percentage figures reflect the sample response rates corrected by sampling weights to define unbiased estimates. The projected total number of households purported below to participate in various activities are estimated as the product of these weighted response rates and the approximately two million households residing in the Baltimore/Washington SMSA (the 1980 Census reported 1,876,144 households).

On the basis of the telephone survey, 43 percent of the region's households are estimated to have used or intended to use the Bay for some recreational activity in 1984. Participation rates varied across the region (see Table 3.1) with Anne Arundel County having the highest percentage use (69%) and the District of Columbia the lowest (21%). Of the remaining areas, Northern Virginia had the next lowest participation rate (37%) and Montgomery County the next highest rate of participation (48%).

The households used the Bay for a variety of recreational activities. Swimming/beach use was the most popular, with a projected 740,000 households participating. The next most popular activity was boating which attracted a projected 620,000 households. Sightseeing (estimated 586,000 households) and fishing (estimated 477)000 households) were also very popular. The projected number of households who used the Bay in conjunction with hunting totalled only about 45,000. There were an estimated 170,000 households that reported other uses of the Bay.

As one might expect, households often participate in more than one activity. For the major use activities of swimming, fishing and boating, Table 3.2 shows the percentage of respondents who participated in one activity or more. Roughly speaking, about one-third of the households participated in all three activities, one-third participated in two of the three activities, and the remaining one-third participated in a single activity. This distinction has importance for benefit estimation; if any one household's participation were limited to only one activity, independent behavioral studies of each activity

Table 3.1

Participation Rate" in Chesapeake Bay Activities
By Activity and Area, 1984

	Northern Virginia[b]	District of Columbia	Montgomery county	Prince George's end Charles Counties	Anne Arundel County	Baltimore[c]	Others[d]
% Participation in CB Activity (1984)	22	9	37	34	60	36	36
% Participate or' Intend to Participate	37	21	48	46	69	45	42
% Participate CB Fishing	12	8	16	18	33	19	21
% Participate CB Swiming	10	R	24	21	33	23	23
% Participate CB Boating	17	8	26	24	4B	24	33
% Participate CB Hunting	1	0	1	0	5	2	3

[a]Weighted percentage, representing a random sample of Baltimore-Washington, D.C. SMSA's

[b]Includes Fairfax, Arlington, Prince William and Loudon counties and the cities of Alexandria, Fairfax and Falls Church.

[c]Includes Baltimore City and portions of Howard and Baltimore counties.

[d]Includea Carroll and Harford counties and portions of Howard and Baltimore counties.

Table 3.2

Joint Participation Rates[a] in Chesapeake Bay Activities By Activity and Region, 1984

	One Activity			Two Activities			Three Activities
	Fishing	Swiming[b]	Boating	Fishing Swimming	Fishing Boating	Swimming Boating	Fishing Swimming Boating
Overall	3	14	10	9	9	20	34
Northern Virginia	3	15	11	6	9	15	38
District of Columbia		10		15	5	15	54
Montgomery County	1	22	12	8	9	22	26
Prince George's and Charles counties	8	17	7	7	11	19	31
Anne Arundel County	3	3	10	7	10	34	33
Baltimore City and County	3	13	9	12	6	20	37
Other Maryland	3		15	4	20	18	40

[a] Weighted percentages, representing a random ample of the Baltimore-Washington, D.C. SMSA's.

[b] Swimming includes beach use.

could be aggregated to provide the basis *of a* total benefit estimation for improved water quality. Multiple participation and the interdependence among activities prevents straightforward addition of benefits calculated in demand studies of individual activities.

While it may be necessary eventually to undertake a comprehensive benefit analysis of all Bay activities? there is enough current information to shed some light on the value of the recreational use of the Bay. Independent studies are useful, if for no other reason than to establish "conditional" relationships between activities and key factors. This may facilitate future studies by isolating key factors for which information is critical. Moreover, by analyzing a series of partial systems, bounds may be established on the total potential benefits.

Aggregate Willingness to Pay

This portion of the chapter employs the contingent valuation technique to value improvements in water quality in the Chesapeake Bay. The hypothetical circumstance posed to survey resondents involves the alteration of the Bay's water quality from its current condition to an improved condition which, in the respondent's view, is acceptable for swimming. . Because individuals' perceptions of water quality are not easily linked to objective measures (see Chapter 2) and because individuals do not easily understand these scientific measures, the hypothetical circumstance was framed in terms of the respondent's acceptability. This limits the specific application of the results, since there is no simple way to determine at what point clean-up efforts raise the water quality to an acceptable level for everyone. However, the evidence presented in Chapter 2 offers some guidance as well as some historical perspective.

The households responding to the contingent valuation experiment are a subset of the telephone survey of the Baltimore-Washington SMSA's. Each of the randomly selected households was asked:

> "Do you consider the water quality in the Chesapeake to be acceptable or unacceptable for swimming and/or other water activities?"

Of the 959 respondents, over one-half (57 percent) found the water quality unacceptable. 'l'hose who responded that it was unacceptable were asked:

> "Would you be willing to pay ($A) in extra state or federal taxes per year if the water quality were improved so that you found it acceptable to swim in the Chesapeake?"

The amount of money ($A) was varied randomly from $5 to $50 over the sample. The percentage of respondents who answered "yes" is shown in Table 3.3.

Table 3.3

Percent of People Willing to Pay Additional Taxes for Acceptable Water Quality for Swimming, by Amount of Tax

Amount of Tax Increase	$5	$10	$15	$20	$25	$30	$35	$40	$45	$50
Percent of Respondents Willing To Pay Tax Increase	64	66	63	70	58	46	57	47	47	53

If sample sizes were big enough, monotonically decreasing percentages over the entire range would likely be revealed. Nonetheless, the percentages are in general declining as the amount of the tax increases. Of those who were presented a tax of $5, $10, $15, or $20, an average of 66 percent agreed (hypothetically) to accept the tax burden in exchange for acceptable water quality. Of those presented a tax of $25, $30, $35, or $40, the average percentage dropped to 52 percent.

Analysis of Willingness to Pay Responses

Hanemann (1984) describes a method for analyzing a central tendency in willingness to pay from questions with "yes" or "no" answers. Let the respondent derive utility from the nonmarket good, water quality, and from money income (y) which can be used to purchase marketed goods. Also let a vector (x) of individual characteristics affect his utility. Utility is given by $u_1(1, y; x)$ when the water quality is acceptable and $u_0(0, y; x)$ when it is not. The functions u_1, and u_0 are not known, and thus are considered stochastic to the researcher; That is

$$u_j(j, y; x) = v(j, y; x) + \nu_j \qquad j = 0,1 \tag{3.1}$$

where ν_j independently and identically distributed random variables with mean zero.

When offered swimmable water at a tax of $A, the individual will accept the tax providing that

$$v(1, y-A; x) + \nu_1 \geq v(0, y; x) + \nu_0 \tag{3.2}$$

and decline otherwise. In this framework, the individual's response becomes a random variable with probability density

$$p_0 = \Pr\{\text{accept tax in exchange for swimmable water}\}$$

$$= \Pr\{v(1, y-A; x) - v(0, y; x) \geq \nu_0 - \nu_1\}$$

$$p_1 = \Pr\{\text{not accept tax in exchange for swimmable water}\} = 1 - p_0.$$

Define $\eta = \nu_0 - \nu_1$ and let $F_\eta(\cdot)$ be the cumulative distribution function of η. Then the probability *of* accepting the tax in exchange for swimmable water equals $F_\eta(\Delta v)$ where Δv is the difference between the deterministic portions of the utility function in the two states (see equation (3.2)}.

At this point any of a number *of* utility functions, individual characteristics, and density functions to complete the analysis could be chosen. Like Hanemann, we chose a logistic cumulation distribution function. Also, we chose a linear function (see Sellar, Chavas and Stoll for the limitations *of* this form) for v(0), such that

$$(3.3) \qquad v(j, y) = \alpha_j + \beta y, \qquad \beta > 0$$

where the arguments *of x* have been temporarily suppressed. The difference, Δv, is $(\alpha_1 - \alpha_0) - \beta A$, which gives a probability model of the form

$$(3.4) \qquad F(\eta) = \prod_{i \in S_1} F(-\alpha_0 + \alpha_1 - \beta A_i) \prod_{i \in S_0} [1 - F(-\alpha_0 + \alpha_1 - \beta A_i)]$$

where S_0 is the set of individuals refusing to pay the tax, and S_1 its the set accepting the tax.

Conceptually, we sought the value A for which

$$(3.5) \qquad u(1, y-A; x) = u(0, y; x).$$

Combining equations (3.2) and (3.3) produces the result that when (3.5) holds, A is defined as the following

$$A = [(\alpha_1 - \alpha_0)(-\eta)]/\beta.$$

Since η is random, so is A. To evaluate A we chose to *take* its expectation, assuming α_0, α_1, and β to be constants, which yields

$$E[A] = (\alpha_1 - \alpha_0)/\beta. \quad (3.6)$$

Thus, $(\alpha_1 - \alpha_0)/\beta$ is the expected (or average) tax that would make an individual just indifferent to paying the tax in exchange for acceptable water quality and not paying the tax but forgoing good water quality. Now we need estimates of the parameters a $_1$, α_0, and β to get a value for E[A].

Results *of* Analysis. BY Subgroups of Respondents

In developing the theory it was admitted that individual characteristics (designated by the vector x) were likely to affect the utility function which in turn would affect the parameters in (3.6). Some of these characteristics are strictly idiosyncratic and not worth trying to model, but others may be associated with identifiable subgroups *of* the population. Three means of subdividing the population suggest themselves--by household income, by race and by Bay user/nonuser. In the sample obtained in 1984 there was sufficient correlation between race and income to make the separate treatment *of* these infeasible. Additionally, it was difficult to subdivide the population by income because income appears in the data set as a continuous variable and arbitrarily dividing it into ranges did not prove useful.

After some preliminary logit analysis, a modification *of* the model shown in (3.4) was estimated. One modification entailed making the (*1 - α_0) depend on whether someone in the household had used or intended to use the Chesapeake Bay in 1984. A variable (D_1) was included to reflect use. This approach allows us to test whether users value the change in the Bay's water quality more than non-users, ceteria paribus. The other modification involved making the bid coefficient, β, depend on the racial classification. Because there is a wide disparity in income between whites and non-whites (average of $40,000 annually vs. average of $25,000), the marginal utility of income, which β represents, maY be different for the two groups. Use *of* a binary variable (D_2) in conjunction with the tax variable permitted an examination of the effect *of* race on the marginal utility of income.

The results of the estimation are reported in Table 3.4. The amount of the tax significantly reduced the probability that a respondent would agree to pay the annual tax increase. Also significant were the use/intercept interaction variable and the tax/race interaction variable. Both users and whitea were more likely to accept the tax increase.

Table 3.4

Logistic Model Estimates Related to the Probability a Respondent Will Accept a Tax Increase

Variable[a]	Estimated Coefficient	Standard Error	t-ratio
Constant $(\alpha_1 - \alpha_0)$	.385	.222	1.73
D_1 · Constant	1.084	.202	4.77
Amount of Tax	- .043	.009	- 5.3?
D_2 " tax	.035	.007 "	4.78

Chi-squared = 47.10

[a]D_1, D_2 represent binary variables for the use of the Bay and white racial characteristics, respectively.

The above results are difficult to interpret because of the high correlation between race and income. It should not be assumed that whites, ceteris paribus, have a higher willingness to pay for water quality. There is insufficient data, however, to test the separate *effects* of income and race. To determine whether willingness to pay changes by income classes, the analysis was reworked and estimates for the expected value *of A* were obtained for five arbitrarily defined income classes ($0-$20,000; $20,100-$50,000; $50,000-$80,000; over $80,000; income not reported). We thus assumed the utility function (3.3) was linear in income only within the ranges described above. Additionally we allowed the $(\alpha_1 - \alpha_0)$ estimate to vary depending on whether an individual was a user or non-user during 1984.

The results are shown in Tables 3.5 and 3.6. The coefficients are *of* the proper sign although. their statistical significance is not overwhelming. Income classes, however, do appear to be an important determinant of the willingness to pay. The results in Table 3.4 suggest that willingness to pay at first rises with income and then falls with the highest willingness to pay coming from the middle income group ($20,000-$50,000).

Returning to the stronger results of Table 3.4, but bearing in mind the correlation between race and income, the expected willingness to pay of a randomly chosen individual in each of *four* subgroups is computed and presented in Table 3.7. The values are divided on the basis of use and racial composition of the household. In addition, standard errors for the calculations are shown. They are computed on a first-order approximation basis (Kendall and Stuart, pages 228-332) assuming independence *of* coefficients. A problem arises with the estimate *of* expected willingness to pay by white users of the Bay. The expected value is substantially out. of the range of the tax increase asked in the survey. Because it is computed as a ratio *of* estimated coefficients, there is nothing to guarantee the value will lie within the range of values used in the questionnaire. However, predictions which fall outside

Table 3.5

Estimates of Utility Parameters by Income Group

Income Class	$\widehat{\alpha_1 - \alpha_0}$ Users	Non-users	$\hat{\beta}$	Sample Size	Likelihood Ratio
$0 - $20,000	1.282 (1.89)″	.833 (1.72)	.028 (1.73)	99	19.35
$20,000- $50,000	1.652 (2.96)	.968 (2.04)	.012 (.81)	200	11.05
$50,000 - $80,000	1.695 (.98)	1.471 (2.80)	.017 (.95)	101	42.33 .
Over $80,000	1.157 (2.81)	.543 (1.24)	.013 (.90)	22	5'?.79
Income not reported	.533 (1.53)	.200 (.42)	.016 (1.11)	93	9.68

W-statistic in parenthesis

Table 3.6

Expected Value of Willingness to Pay
for Acceptable Water Quality for Swimming by Income Group and User Group,
1984.

Income Class	Expected Value of Willingness to Pay: Average for All	Average for Users	Average for Non-users
o - $20,000	$ 38.54	$ 415.94	$29.85
$20,000-$50,000	108.60	134.25	78.48
$50,000-$60,000	95.16	101.20	88.08
over $80,000	66.'44	89.00	41.77
not reported	22.26	32.64	12.25

Table 3.7

Estimated Willingness to Pay for Acceptable Water Quality
by Participation and Racial Composition of Household
1984.

	Expected Willingness to Pay	
Participation Status	Racial Compos it ion	
	White	Non-Whit e
User	$183.63 (55.12)[a]	$34.16 (10.40)
Non-User	$48.13 (10.25)	$ 8.95 (2.53)

a Standard deviation in parentheses

the range are less reliable. The results suggest that a wider range of tax increases would have yielded more confidence in the estimates' accuracy. Individual willingness to pay bids for water quality improvements appear to have a larger range (i.e. take on larger values) than we anticipated when constructing the survey.

In Table 3.8 the average willingness to pay for each subpopulation is combined with estimates of the subpopulation size to project total willingness to pay figures. The values are based on the telephone sample estimate that 57 percent of the population find Chesapeake Bay water quality unacceptable and on the sample percentages of white users (27%), white non-users (35%), non-white users (16%) and non-white non-users (21%).

Expected values as well as optimistic and pessimistic values are shown. The optimistic (pessimistic) value is derived using the expected value of willingness to pay plus (minus) one standard deviation. On the basis of these estimates, we could argue a reasonable range of willingness to pay values of $60 million to slightly over $100 million. Care must be exercised when considering the standard deviation, as it is computed as an approximation and is not associated with the normal distribution. The values shown, however, represent an "order of magnitude" contingent valuation estimate of willingness to pay for improved water quality.

Table 3.8

Estimated Aggregate[a] Willingness to Pay for Water Quality Acceptables for Swimming, by Classification and Scenarios 1984

	Scenario		
Wingness to Pay	"Average*'[b]	"Optimistic"[c]	"Pessimistic"[d]
	---- ---- --- Thousand $ ----------		
User			
White	55,838	72,595	39,081
Non-white	6,164	8,020	4,271
Non-user			
White	19,505	23,641	15,409
Non-whit e	2,105	2,720	1,514
Aggregate	83,612	106,976	60,275

[a]Baltimore-Washington SMSA population
[b]Based on expected willingness to pay
[c]Based on expected willingness to pay plus one standard deviation
[d]Based on expected willingness to pay minus one standard deviation

Regional Comparisons

Stretching the data somewhat further, one can also examine geographical patterns of responses. The logistic model wae re-estimated using sub-samples grouped by region: the Southeast region (Prince George's County, Charles County, Anne Arundel County and the District of Columbia), the Western region (Northern Virginia, Montgomery County) and the Northern region (Baltimore

City and County, Howard County, and Harford County). The sub-samples represent groups, each of which exhibits reasonable internal homogeneity, for which we have at least one-hundred and fifty *responses.* Even with these conditions, however, the statistical results are less significant than the earlier ones because *of* the smaller sample size.

The results suggest regional similarities and differences (Table 3.9). Some consistency is evident as signs on all coefficients are the same for all regions. Thus an increase in the hypothetical tax decreases the probability of acceptance of the tax associated with water quality improvement. Additionally the effect of participation and race on willingness to pay for the improvement is consistent across all regions.

Table 3.9

Logistic Model Estimates Related to the Probability a Respondent Will Accept a Tax Increase to Improve Chesapeake Bay Water Quality, by Geographic Area

Variable	Southeast[a]	West[b]	North[c]
Constant	.334 (.94)[d]	.71 (.46)	.12 (.30)
D_1 " constant	.78 (2.36)	1.02 (2.49)	1.67 (4.77)
Amount of Tax	-.050 (3.33)	-.070 (3.04)	-.023 (1.77)
D_2 . Tax	.041 (3.15)	.060 (3.00)	.015 (1.36)
Chi-squared for Likelihood ratio	36.5	37.2	48.6

[a]Dist. of Columbia and Counties of Prince George's, Charles and Anne Arundel
[b]Nort hem Virginia and Montgomery County
[c]Baltimore City and Count iee of Baitimore, Harford and Howard
[d]t-ratio in parentheses

There are, however, systematic differences across regions. Users from the Northern region are willing to pay on average substantially more than those from the southeast or western regions. The figures for nonusers are less disparate across regions, with those for the West region somewhat larger. The estimated willingness to pay figures are presented in Table 3.10.

Table 3.10

Estimated Willingness to Pay for Acceptable Water Quality by Region, Participation, and Racial Composition of Household, 1984.

Household Characteristic	Region: Southeast	West	North
White, User	$124	$133	$224
Non-White, User	22	25	77
Non-White, Non-user	7	10	5
White, Non-user	3'?	55	15

Existence Value

In the preceding contingent valuation experiment we present non-zero willingness to pay estimates for non-users as well as users. There are a number of reasons why non-users may be willing to pay for improved water quality. One of these reasons has been labelled existence value by non-market benefit analysts (Krutilla) and stems from early experiences applying benefit cost analysis to water resources projects. Individuals who never use a resource either directly or indirectly <u>and</u> never intend to uae it may still be willing to pay to improve ita quality or assure its existence. Formal studies of existence value are limited, but some empirical evidence exists. Fisher and Raucher (1984) suggest that nonuse benefita (including both option value and existence value) are some fraction of the use value of water quality changes. Other research (e.g., Walsh et al., 1985; Schulze et al., 1983) suggests that existence value may be greater than use value, and sometimes substantially so.

Existence value is a frequently cited concept in the literature, and several studies have attempted to derive explicit estimates of existence value associated with water quality (Mitchell and Carson, 1981; Cronin, 1982; Walsh et al., 1978; Desvousges et al., 1983). Nonetheless, no consensus exists on the models which underlie the measurement. Behaviorally based methods of welfare measurement are unsatisfactory because, by definition, existence value is unconnected with behavior. Suspicion surrounds contingent valuation estimates of existence value because these estimates are even less susceptible to proof or disproof than contingent valuation estimates of use values. Even more to the point, the success of a contingent valuation approach depends on well defined questions. Without a clear idea of the motivations behind existence value, properly focused questions are difficult to define.

The Existence Value Experiment

In this section we present some preliminary results of an experiment designed to shed some light on the motives behind existence value for the Chesapeake Bay. The sample frame was derived from the phone survey described above. The households contacted randomly by phone were asked if they would complete an additional mail survey. Of the 1,044 contacted, 741 agreed to fill out and return a brief mail questionnaire regarding water quality in the Chesapeake Bay, and of these 741 households, 282 actually returned the questionnaires. Because only about 70 percent of those contacted agreed to receive the mail questionnaire, and only 38 percent of those who agreed actually returned these questionnaires, these results should not be taken as representative of the population sampled but as useful for gaining preliminary y insigh ts into willingness to pay motives.

The 282 respondents were grouped as users or non-users. Users were defined as all respondents who currently use the Bay or thought they might do so in the future. Respondents who felt certain that they would not use the Bay for recreation at any time in the future were defined as non-users. Non-users accounted for 16.3 percent of the respondents.

Respondents were asked to consider a series of situations concerning public beaches surrounding the Chesapeake Bay. They were asked to assume that water quality at these beaches had fallen below a level acceptable for swimming, They were told that a project could be undertaken that would clean the beaches so that a water quality level acceptable for swimming was achieved and maintained. The respondents were then asked the following question under four scenarios:

"Would you prefer that the clean-up project be undertaken?"

Scenario 1, No additional information.

Scenario 2. Access to the beaches by the public is permanently denied so that even if clean, the beaches will not be used.

Scenario 3. If the project is undertaken, taxes would be raised so much that nearly everyone prefers that the project is not undertaken. These taxes would be paid by individuals other than the respondent.

Scenario 4. If the project is not undertaken, funds would instead be used to improve hospital services in selected communities surrounding the Bay. Of all the people who care, half want the beaches cleaned, and half want improved hospital services, The respondent himself would never need to visit any of the improved hospitals.

The proportion of "yes" responses for users and non-users under each scenario is given in Table 3.11.

Table 3.11

Summary Results of Contingent Valuation Experiment on Existence Value

Scenario Number	Proportion of Yes Responses: Users [a]	Standard Error of Difference	Proportion of Yes Responses: Non-users[b]	Standard Error of Difference
1	.96		.83	
2	.70	.032	.69	.088
3	.71	.032	.67	.088
4	.49	.035	.37	.091

[a]The number of users in the sample of respondents is 236.
[b]The number of nonusers in the sample of respondents is 46.
[c]This is the standard error of the difference between the proportion in Scenario 1 and the proportion in the given scenario.

Interpretation of the Results

In order to interpret the responses reported in Table 3.11, it is necessary first to consider the ‘potential motives for existence value. Two broad motives may be discerned: intrinsic and altruistic. Existence value based on intrinsic motives stems from a concern about the state of the world. Concern about the order of things may cause people to suffer simply by learning about pollution incidents. What has been called the “environmental ethic” is closely linked with the intrinsic motive.

Of concern here is the second of the two motives: altruism. People can gain value from the enhanced wellbeing of others (individualistic altruism). An extensive discussion of these altruistic motivations can be found in Madariaga and McConnell (1987).

Responses to the question under Scenario 1 are used as a control to be compared with responses under Scenarios 2 through 4, where Scenario 1 is purposely ambiguous about ‘project costs. As expected, moat respondents preferred that the project be undertaken under Scenario 1. Interpreting non-user responses of “yes” as evidence of existence value, the relatively high number of non-users giving positive responses is consistent with the results of previous studies that have found evidence of existence value.

With access to beaches denied under Scenario 2, the number of "yes" responses to the question predictably declined. Since the number of non-user responses of '*yes" declined when access was denied, it appears that existence value, at least to some individuals, is related to others' use. Thus, altruism may , be one motive that underlies existence value. However, even with access denied, most respondenta preferred that the project be undertaken. This may reflect the presence of a number of motivational including an environmental ethic. Finally, it is interesting to note the closeness of user and non-user group responses under Scenario 2. Since with access denied there can be *no* users, "yes" responses from the user group will also indicate positive existence value. In this scenario, the proportion *of* users and non-users exhibiting existence value was nearly identical.

Scenario 3 is similar to Scenario 2 in that both attempt to eliminate altruistic motives. In this scenario, the Bay can be used after the cleanup, but other individuals will be forced to pay more than what the improved water quality is worth to them. The similarity *of* proportions in Scenarios 2 and 3 supports the notion that the Chesapeake resource is valued for its own sake. In Scenario 2, about 70 percent of the people support the project despite the fact that there is no *use* and hence no direct use value. In Scenario 3, roughly the same proportion supports the project even though there is no net value to the users.

Under Scenario 4 the number *of "yes"* responses *fell* dramatically compared with the responses under Scenario 1. Since less than half *of* the non-users preferred that the cleanup project be undertaken, it appears that the improved hospital services are on average at least as valuable as clean water in the Bay.

The individuals were instructed that they would not need the services of the hospital, themselves, so it is tempting to label their value for the improved hospital services as existence value. However, the entire value of the hospital services may be due to altruistic motives while individuals appear to have motives beyond altruism for Chesapeake water quality improvements.

Conclusions

The underlying motives for *existence value* matter to the proper design and interpretation of contingent valuation experiments. The preliminary results concerning *existence* value associated with the Chesapeake Bay suggest some ambiguity about its motivation. People are willing to pay for water quality improvements in the Bay, but how much they are willing to pay depends on the specific nature *of* the opportunities foregone by doing so. Among other considerations, these suggest attention should be paid to the methods for financing the cleanup *of* the Bay.

Chapter 4

The Effect of Chesapeake Bay Water Quality on Beach Use

The previous chapter contains a range of benefits from improved Chesapeake Bay water quality, based on a contingent valuation experiment. Although there is substantial evidence to suggest that the responses to the hypothetical questions were not random but rather associated with households' use of the Bay and racial/income strata, problems still exist with the approach. Follow-up questioning revealed households did not consider alternative uses of tax increases (e.g. improvements in other public goods such as hospitals, roads, etc.). Moreover, the subjective nature of the water quality measurement used in the contingent valuation question does not lend itself easily to policy analysis, based as it is on objective (scientific) measures of water quality. Finally, the values represent aggregate values, indistinguishable on the basis of type of recreation or geographic location of pollution. Knowledge of user group and geographical impacts of programs can provide a depth and richness of understanding important in the political process.

The remaining chapters are devoted to providing analyses of the observed behavior of households based on data gathered in previous studies which are specific to different recreational activities. The analyses use cross-sectional information on households to model beach use, boating and recreational fishing. Once demand functions are estimated, benefits from access and from changes in water quality are assessed for each of these activities.

This chapter contains a cross-sectional analysis of beach use on the western shore of Maryland. It draws from the random telephone survey of the Baltimore-Washington SMSA's and a stratified random survey of twelve public beaches on Maryland's western shore. As such, the analysis is not comprehensive of all beach use in Maryland but rather the use of the public areas in one portion of the Bay by the citizens in the surrounding environs of the two large metropolitan areas closest to the Bay.

A number of approaches to estimating recreational response to environmental quality changes have evolved. Many of these depend first on the estimation of demand for recreational activities which are closely linked to the environmental resource in question. The recreational demand models currently in use have grown out of the union of neoclassical demand theory and the travel cost model proposed by Hotelling and employed extensively by recreational economists for the paat several decades. The principal contribution of the travel cost model is *found* in the use of the travel cost to the recreational sita as the principal component in constructing a "price" for the recreational commodity. The simple travel cost model can be derived from a neoclassical utility maximization framework, as can more complex models which incorporate added dimensions to the problem (see Bockstael, Strand and Hanemann, 1986).

One particularly important modification of the simple model is the introduction of quality characteristics of recreational sites (see Volume I of this report for the theory). If the recreational demand model is to be used to estimate the value *of* environmental quality improvements then individuals' behavioral responses to changes in quality must be modelled. This requires observing behavior in the context of differing levels of environmental quality, which can generally be done only by examining recreation behavior at a given point in time over a group of sites which vary in quality.

The procedure can lead to a number of specific methods of analysis (see Kling, Bockstael and Strand, 1985), each imposing a different set of restrictions/assumptions on recreational behavior. While there is no concensus regarding the "correct" model, the two most prominent. models in the literature can be categorized as the (modified) neoclassical model and the discrete choice model. The neoclassical model has the form of the traditional demand system, with quantities being a function of prices and water quality. The model is modified in some way to facilitate the inclusion of water quality parameters which do not tend to vary for a given site over the population, Additionally, demands are generally treated independently. A common approach is the varying parameter model (VPM), as put forth by Smith, Desvousges and McGivney (1986). Here, independent single-site models of recreational trip demand are estimated, and the estimates of the intercept and price coefficient are correlated with the site's water quality. Then, in policy analysis, changes in water quality change the intercept and slope *of* the demand curve, thereby influencing quantity consumed and the welfare derived from recreational activities.

The discrete choice model (DCM) has also taken many forma (e. g., Caulkins; Morey and Rowe) but the form employed by Bockatael, Hanemann and Strand is representative. In this model, the individual is viewed as having a number of choice occasions upon which to select a site. The selection of site is discrete in the sense that only one site is chosen per choice occasion. Site characteristics such as travel cost, water quality and facilities are used to explain the choice of a site on any given occasion. A composite "value" reflecting the desirability of available choices is computed from the discrete choice estimation, and this is used with other factors to estimate the number of choice occasions.

Although both models are behaviorally based, there are advantages and disadvantages associated with both. The varying parameter model starts *from* the assumption that the demand functions for trips to sites are interior solutions to a utility maximization process. The discrete choice model, however, starts from the viewpoint that, on any given occasion, an individual chooses among a finite set of alternative sites. Neither approach is perfectly satisfactory. In the DC model, the link between the number of choice occasions and the site selection per choice occasion is ad hoc. With the VP model, the demand for any one site does not adequately reflect the alternatives. Additionally, the fact that individuals do not visit all sites is inconsistent with the implicit theory and must be handled econometrically. Kling has employed Monte Carlo studies to examine the performance *of* these models. Not surprisingly, her results suggest that the VP model excels when most recreationalists tend to visit almost all alternative sites in a season, and the DC model excels when most tend to visit one or only a *few* sites in a season.

Most recreational data sets will be characterized by something between the two extremes, however neither model has an obvious advantage, and no tractable model is perfectly consistent with this situation.

In this chapter both the varying parameter and discrete choice models are applied to western shore beach use in Maryland. In subsequent chapters only the varying parameters model will be applied since neither the boating nor fishing data can support the data intensive discrete choice model. The data on beach use at western shore beaches is relatively rich, however. Both types of models will utilize this same data set of Chesapeake Bay beach users in the subsequent analysis. The results will be a range of values which suggest orders of magnitude for welfare measures of hypothetical changes in water quality.

The Survey and the Data

This section is devoted to a description of the survey of Chesapeake Beach Use conducted in 1984. Unlike the data used in analyses of boating and fishing in Chapters 5 and 6, the data used in this chapter were collected during an earlier budget period of this cooperative agreement. Great care was taken with the sampling frame to improve confidence in the results. Because the survey itself is important to the project, the content and procedures are described extensively in Appendix C. A copy of the survey instrument can be found in Appendix D.

From May 26, 1984 to August 19, 1984, Research Triangle Institute (RTI) interviewed individuals on the western shore beaches in Maryland. The study population consisted of all residents of the Baltimore and Washington, D. C., SMSA'S, age 14 or older, that used these beaches for recreation in 1984. More specifically, the population was limited to recreational users of the following 12 beaches:

Beach	Strata: Geographic	Strata: Size
1. Sandy Point	north	large
2. Point Lookout	south	large
3. Fort Small	north	small
4. Miami	north	small
5. Rocky Point	north	small
6. Elm' s Beach	south	small
7. Bay Ridge	south	large
8. Kurtz	north	small
9. Breezy Point	south	small
10. Rod & Reel	south	small
11. Morgantown	south	small
12. North Beach	south	small

Four hundred and eight individuals were interviewed at the beach to learn of their recreational patterns and perception of water quality at these beaches. These individuals were randomly selected from sample beaches and days. The sampling design can be described as a two-stage stratified sample in which a probability y sample of beaches and days was selected , and a random systematic sample of persons was interviewed at each sample site (day-beach combination) .

The User Intercept Survey Questionnaire was designed to record and collect the following:

- Frequency of visits made to beaches on the western shore of the Chesapeake
- Activities that the respondent (and his/her family) participated in when visiting beaches
- Activities not participated in and the reason why they *were* not
- Cast related to a typical trip to each beach that the respondent had visited since January 1, 1984
- The respondent's perception of the quality *of* the beach and the beach facilities at each beach with which he/she was familiar
- Factors that influenced a respondent's decision to visit or not visit a beach
- The respondent's willingness to continue to visit the sample site if costs related to the use *of* the beach were to rise.

In addition, a series of demographic questions was included to enable analysts to establish profiles of beach users.

The Data

Household Trips

Respondents were asked, on-site, how many trips they had taken in 1984 prior to the interview and how many they intended to take during the rest of 1984. Follow-up telephone interviews at the end of the seaeon obtained complete 1984 trip information for 251 *of* the 408 beach users interviewed. For the remaining households, information was obtained solely on-site.

To assure consistency in our trip measurement, the end of the season information was compared with in-season response so that a correction factor could be applied to households with only "in-season" information." Using data from the largest beach (Sand y Point), a regression of end-of-season trips (x_e) on reported plus intended trips during the season (x_r) yielded:

(4.1) $$X_e = .686 + .632X_r + \varepsilon \qquad R^2 = .89 \qquad (n = 148)$$
$$(1..40) \quad (35.00)$$

where the t-statistics are in parentheses. Equation (4.1) was used to predict total trips to a site from on-site information for households that did not receive follow-up inteviews. The combination of a fairly small constant term and a coefficient on X_r which is less than one suggests that households tend to report intentions in excess of trips later realized.

Access Costs and Time Costs

Previous studies (e.g. Bockstael, Hanemann, and Strand, 1986) have considered travel costs to include the person's (or household's) monetary costs of travel as well as the opportunity costs of their time. Distance to a site, transformed into transportation costs is a feature common to all visitors. However, those individuals who forego income in order to take time to recreate incur monetary expenses in excess of transportation costs. For these individualist these costs can be measured as the foregone wage rate times the time spent accessing the activity.

For households without employed persona or with employed persons with fixed work schedules, there is no direct loss of income incurred when recreation is undertaken. The opportunity cost of recreation time for these individuals is the value of foregone alternative activities. Unfortunately, opportunity costs will vary over individuals in ways which are not observable. The only observable factor related to the total opportunity cost of the recreation experience will be the time spent traveling and recreating. Even this measurement is troublesome, however, since the on-site portion of this time also measures the amount of the recreational good consumed. To avoid many of these complications we employ only round-trip travel time as a surrogate for opportunity costs in these cases.

In addition to these access costs, most western shore beaches have an admittance fee which must be added to the other costs of traveling to the site. Often the fee will vary depending on the day of the week and size of party.

Water Quality

The Chessie System environmental quality data, maintained by EPA's Chesapeake Bay program, were' used to construct the water quality measures. Turbidity, bacteria counts, total suspended solids, total nitrogen, total phosphorous, and total chlorophyll A are among the potential indicators of water quality to which beach demand might be sensitive, Since these , exhibited a high degree of collinearity, two variables were extracted from the data set to use in this analysis: total nitrogen and total phosphorus. A good case can be made for using these variables. Studies of the Bay conducted by the U. S. Environmental Protection Agency indicate that perhaps the most significant problem facing Bay restoration and protection efforts is nutrient over-enrichment of Bay waters. Excessive nutrient levels may be the partial cause of decreased submerged aquatic vegetation, which in turn has adverse effects on the food chain and on the habitat for many fish species. Further, over-enrichment leads to lower dissolved oxygen levels which have additional adverse effects on fish stocks, degrading the appearance of the water as well.

High collinearity y between nitrogen and phosphorus readings prevented separate inclusion of both variables in the analysis. The product of nitrogen and phosphorus was used to avoid this problem and to capture the interactive nature of these nutrients.

In each case, mean monthly water quality levels from April through September 19?7 were calculated for areas of twelve counties contiguous to the Bay, The summer months were chosen because they represent the peak of recreational activity. Complete data over regions of the Bay were available for only some years, 1977 being the closest to the survey year. The relative water quality readings across the Bay are unlikely to be considerably different between the two years, even if the absolute readings are different. Additionally, individuals' decisions are unlikely to be related solely to water quality in the current year, but will be based on a cumulative learning process which includes past observations as well. Consequently, there is no obvious correct choice, and the errors associated with using data from any one year are unclear.

Other Variables

Additional factors are known to influence recreation activity, including the ownership of certain types of household capital equipment. Boats, recreational vehicles and swimming pools are the types of capital equipment which may affect the use of beaches on the western shore. Some of these beaches have boat-launch facilities, some camp sites, while others offer good swimming possibilities. Years living in the area, previous recreational history, family size and participation are some other factors which may be important.

The Varying Parameter Model

To formalize the model of behavior. the individual is assumed to maximize a constrained utility function which is a function of number of trips taken to each of n quality-differentiated sites, the quality characteristics of each site, and a Hicksian good. Thus

$$(4.2) \qquad \max u(x, q, z) \qquad \text{s.t. } px + z = y$$

where x is an n-dimensional vector of trips to the n sites, p is a corresponding vector of costs of accessing the sites, q is a matrix of variables q_{ij}, $i = 1,\ldots,n$ and $j = 1,\ldots,m$, where q_{ij} is the level of the j^{th} quality characteristic at the i^{th} site, z is the Hic sian good, and y is income. To simplify notation in this section, we will assume that there is only one quality characteristic, and thus m = 1, and q represents the vector of values of the one quality characteristic across sites.

Problem (4.2) defines n demand functions, each of which may be a function of all *n* prices, n quality levels, and income:

$$x_i = g_i(p, q, y) \qquad i = 1, \ldots, n. \tag{4.3}$$

This model cannot be estimated with cross-section data. Imagine having observations on S individuals who visit site i. Own price (p_i) and substitute prices (p_k, $k \neq i$) will typically vary across individuals if they come to site i from different geographical areas. However, there will be no variation in the quality characteristic at site i (q_i) across the S individuals, nor will there by any variation across individual in the characteristics of other sites (q_k, $k \neq i$). With no variation in the q_i's across observations, their coefficients cannot be estimated, and nothing can be learned about behavioral response to quality changes.

There are *several* methods for resolving the dilemma presented above. Some of them build on the model presented in (4.3) (these are described in Kling, Bockstael and Strand, 1985), while others rely on discrete choice models (see Bockstael, Hanemann and Strand, 1986). The method used in this section, the varying parameters model, falls in the former category and *follows* similar methods applied by Vaughan and Russell (1982); Smith, Desvousges and McGivney (1983); and Smith and Desvousges (1985).

One way to motivate the varying parameters model is to consider *a* simple linear form such as:

$$x_i = \beta_{0i} + \sum_{k=1}^{n} \beta_{1ik} p_k + \beta_{2i} y + \varepsilon_i \qquad i = 1, \ldots, n, \tag{4.4}$$

but to further assume that the parameters in site demand functions are deterministic functions of the quality characteristics. For example, the β's might be linear functions of the q's:

$$\begin{aligned} \beta_{0i} &= \gamma_0 + \gamma_1 q_i + \sum_{j \neq i} \gamma_{2j} q_j, \\ \beta_{1ik} &= \alpha_{0k} + \alpha_{1k} q_i + \sum_{j \neq i} \alpha_{2kj} q_j, \qquad k = 1, \ldots, n, \\ \beta_{2i} &= \delta_0 + \delta_1 q_i + \sum_{j \neq i} \delta_{2j} q_j. \end{aligned} \tag{4.5}$$

The model in (4.4) and (4.5) implies that variations in demand parameters across sites (i.e., variations in the β_{0i}'s, β_{1i}'s, etc.) correspond to variations in own-site attributes (q_i) and subatitute-site attributes (q_j, $j \neq i$). Specifically, the above model implies a demand for trips to site i of the following form:

$$(4.6) \qquad x_i = (\gamma_0 + \gamma_1 q_i + \Sigma \gamma_{2j} q_j) + \sum_{k=1}^{n} (\alpha_{0k} + \alpha_{1k} q_i + \Sigma \alpha_{2kj} q_j) p_k + (\delta_0 + \delta_1 q_i + \Sigma \delta_{2j} q_j) y + \varepsilon_i .$$

Even though the model can be collapsed into *one* expression as in (4.6), the estimation procedure usually involves two steps: the regression of trips to each site on prices and income (e.g., *n* separate regressions) and the regression *of* the coefficients from the first n- regressions on the quality characteristics *of* the sites. The second step requires the application of generalized least squares because *of* the properties *of* the error structure implicit in the estimation *of* (4.5) which must use estimated parameters ($\hat{\beta}$'s) in place of the true β's.

The first-stage estimation procedure is further complicated by the need to correct *for a* censored sample bias. Moat consumer demand problems analyzed with household data encounter this problem. A random sample *of* households will *reveal* a certain (often substantial) number of households that do not consume the good in question and thus have zero as the value of their dependent variable. In the sample, there will therefore be many observations concentrated around zero. Neither omitting the zero observations, nor including them in an OLS regression, will produce unbiased estimates.

Tobin analyzed this problem in 1958 and produced the first of several approaches to handling the problem. His approach applied to the first stage of our varying parameters model characterizes the problem in the following way:

$$(4.7) \qquad x_i = \beta_0 + \Sigma \beta_{1j} p_j + \beta_2 y + \varepsilon \qquad \text{if } \beta_0 + \Sigma \beta_{1j} p_j + \beta_2 y + \varepsilon > 0$$

$$x_i = 0 \qquad \text{otherwise.}$$

While ε may be distributed as a normal, x will not be. The estimation of the β's therefore requires maximum likelihood techniques, where the likelihood function is given by

$$(4.8) \qquad L = \prod_{x>0} \frac{1}{\sigma} \phi\left(\frac{x - z\beta}{\sigma}\right) \prod_{x=0} \Phi\left(\frac{-z\beta}{\sigma}\right)$$

where $z\beta$ is the right-hand side of (4.4), σ is the standard deviation of ε, and ϕ and Φ are, respectively, the density function and the distribution function of the standard normal.

The Varying Parameter Model Estimates

Of the twelve mentioned beaches, there was sufficient data to estimate demand functions for only nine. For two beaches, Kurtz Pleasure Beach and North Beach, there were less than 20 respondents. Additionally, Breezy Point had only 24 observations, and over 10 percent of these were more than one-day trips. We were, however, able to separate the Chesapeake Beach location into two sites, the Chesapeake Beach proper and the Rod and Reel Club beach. Thus there were ten sites initially considered in the analysis.

The arithmetic means of the variables used in the model are shown in Table 4.1. The average is taken over persons actually visiting the site. The largest average number of trips per user occurs at Rocky Point, whereas the smallest occurs at Porter's New Beach. Point Lookout requires on average the greatest monetary and time expenditures for access, whereas Fort Smallwood and Rock y Point have the least average monetary costs per user. Table 4.1 also reports, for each beach, the percentage of users owning certain types of recreational equipment. The percentage of beach users owning boats ranged from a low of 12 percent at Bay Ridge to a high of 19 percent at Porter's New Beach and Miami Beach. The range was larger for recreational vehicle ownership, with as much as a quarter to a third of users at Chesapeake Beach, Rod and Reel, Bay Ridge, Point Lookout and Morgantown being recreational vehicle owners.

There are a number of methods for incorporating substitute site information into recreational demand models (see Bockstael, Hanemann and Kling, 1986), none of which is completely satisfactory. The approach taken here is to identify for each site and each individual one substitute beach. Average access costs and time costs for a substitute beach are included in Table 4.1. For each individual and each beach, the designated substitute beach is the least cost alternative.

The initial set of regressions was run using equation (4.4) as the behavioral model and a tobit estimation procedure as the statistical basis. In some cases, multicollinearity among the cost and time variables required eliminating one or both of the substitute cost variables. In the case of Morgantown, the small number of observations gave such poor results that the site was dropped from the model. The results reported in Table 4.2 were generated using the LIMDEP statistical package and an IBM 4341 computer.

As indicated earlier, the total sample of beach users is 408 individuals. The tobit estimation for any beach j includes both users of beach j (non-limit observations) and individuals who were in the beach sample but did not use beach j. The number of observations in each tobit estimation differs from beach to beach however, because some individuals had missing cost data for some beaches.

Table **4.1**

Average Values of Regression Variables **for Visitors by Beach**

		Beach		Substitute Beach		Ownership		
Beach	Tripe (#/yr)	Access coats ($)	Access Time (hr)	Access coats ($)	Access Time (hr)	Boat (%)	Recreation Vehicle (%)	Swimming Pool (%)
Sandy Point	8.06	15.98	1.29	12.09	.84	15	18	18
Fort Smallwood	5.83	8.66	1.11	6.38	.69	14	20	14
Chesapeake Beach	2.87	18.79	1.45	11.30	.84	17	28	17
Rod & Reel	6.42	22.80	1*58	13.61	.87	13	33	25
Bay Ridge	7.33	15.75	1.14	10.84	.84	12	28	12
Point Lookout	3.85	36.42	2.73	13.10	1.03	17	30	12
Rocky Point	10.20	9.07	.93	6.43	.55	13	12	20
Porter's New Beach	2.92	9.50	.72	5.81	.49	19	11	11
Miami	5.16	11.81	.86	4.82	.59	19	17	17
Morgantown	7.71	26.09	1.22	9.80	1.02	17	35	09

Table 4.2
Tobit Estimates for Beach Demand Model, by Beach[a]

Beach	Constant	Beach: Access Costs	Beach: Access Time	Substitute Beach: Access Costs	Substitute Beach: Access Time	Ownership: Boat	Ownership: Rec. Veh.	Ownership: Swim. Pool	σ	Nonlimit/ Limit Observations
Sandy Point	8.17 (2.83)[b]	-.35 (-4.07)	-4.85 (-3.61)	.24 (2.86)	2.47 (1.15)				14.85 (57.59)	243/139
Fort Smallwood	.16 (.05)	-.53 (-2.86)	-4.24 (-2.58)	.34 (1.14)					9.52 (11.61)	41/198
Rod & Reel	10.44 (--2.18)	“.10 (-.84)	-1.51 (-1.28)	.29 (1.25)					9.72 (5.47)	22/201
Rocky Point	10.29 (2.04)	-.47 (1.45)	-5.63 (-2.38)					3.55 (1.36)	12.41 (19.00)	87/66
Chesapeake Beach	-3.96 (-1.89)	.18 (-2.19)	-1.19 (-1.76)	.19 (1.80)			3.23 (2.58)		6.16 (10.00)	46/272
Porter's New Beach	-.70 (.31)	-.29 (-2.21)	-1.28 (-1.28)	.31 (1.10)		1.54 (1.32)		2.04 (1.31)	3.43 (5.15)	25/118
Point Lookout.	3.49 (-2.72)	-.05 (--5.62)	-1.72 (4.72)	.12 (3.35)	4.55 (5.41)	2.19 (1.69)	2.98 (2.50)	-1.76 (-1.21)	5.96 (15.14)	82/262
Miami	-2.20 (--1.45)	.09 (-1.35)	-1.27 (-1.18)				4.37 (2.46)		7.42 (10.0G)	50/121
Day Ridge	-6.96 (1.16)	-.78 (-4.90)	-9.63 (-3.50)	.83 (3.19)	7.40 (1.96)	-6.19 (-1.00)	7.55 (1.50)	-5.67 (-1.13)	18.06 (17.56)	61/292

[a]No coefficients were significantly different from zero for Morgantown site.
[b]t-ratios in parentheses

The estimated coefficients on own-price (travel cost) were all *of* the expected sign) and most were statistically significant from zero. Beaches for which a reasonably large on-site sample was obtained yielded the most significant estimates. Small sample effects of multicollinearity among the price and time variables likely caused the large standard errors for Miami, Rod and Reel, etc. In some instances, the multicollinearity was sufficiently troublesome that only the own-price and own-time variables were considered. Obtaining results for as many beaches as possible was critical because the sample size in the second-stage estimation equals the number of beaches in the first stage.

The results of the second-stage estimation, i.e. the estimation of equation (4.5), were obtained from a weighted least squares procedure in which the weights were $1/u_{p,j}$, the inverse of the standard error of the own-price coefficient for each beach. The estimated equations are:

(4.10)

$$\beta_{1j} = \underset{(-.04)}{-.0308} - \underset{(-2.22)}{.00020}\ TNP_j$$

$$\beta_{0j} = \underset{(-1.10)}{-2.66} - \underset{(-.001)}{.0016}\ TNP_j$$

where TNP is the water quality variable defined earlier, and the values in parentheses are t-ratios.

The results show no significant relationship between water quality and the intercepts of the beach-use demand equations but a significant relationship between water quality and the coefficients on travel cost. The poorer the water quality (i.e. the higher the level of TNP), the larger the negative response *of* beach users to travel costs. This results in a pivoting inward of the demand curve as water quality deteriorates and a pivoting outward with improvements. The results are in accordance with the proposition that poor water quality lowers beach users willingness to pay for access to beaches.

Estimated Benefit Changes

The analysis above describes the behavioral response of the average western shore beach user to the change in water quality. From this information and information on the number of users of the beaches, we are able to determine some estimates of benefits of hypothetical improvements in water quality to the average user *of* each beach. We are also able to expand to the total population of beach users.

Three hypothetical changes in the environmental variables are considered, a 10 percent and a 20 percent decrease (environmental improvement) in the environmental (pollution) variables, and a 20 percent increase (environmental degradation). Since we will want to assess the *effects* of the change, we will want to calculate consumer surplus before and after the change. The formula for individual i's consumer surplus from site j is given by the following when the demand function is linear

$$(4.11) \qquad CS_{ij} = (x_{ij})^2/(-2\beta_{j1}),$$

where x_{ij} is its demand for trips to j and β_{j1} is the coefficient on cost of access in the j^{th} site demand function. For a given hypothetical change in water quality at beach j, the weighted average change in consumer surplus over the sample is calculated:

$$(4.12) \quad ACS = \sum_{i=1}^{N_j}[(x_{ij}(q_j^1))^2/(-2\beta_{j1}(q_j^1)) - (x_{ij}(q_j^0))^2/(-2\beta_{j1}(q_j^0))]*k_i/N_j$$

where k_i is the weight, q_j^0 and q_j^1 are the levels of water quality before and after the change, and the notation $x_{ij}(q_j)$ and $\beta_{j1}(q_j)$ implies that both demand and the coefficient on travel cost are functions of the level of water quality. N_j is the size of the sample of beach users used to estimate the tobit equation for beach j. The sample includes all 408 observations minus those for which information about beach j was unavailable.

Calculating consumer surplus for hypothetical environmental circumstances (equation 4.12) thus requires values for $x^0 = x(q^0)$, $\beta^0(q^0)$, $x^1 = x(q^1)$, and $\beta^1 = \beta(q^1)$. The first step in assessing the hypothetical changes is to use the results of model (4.10) to predict $\beta_{j1}(q_j^1)$, that is to predict the new travel cost coefficient given the hypothetical change in water quality. The coefficients $\beta_{j1}(q_j^0)$ and $\beta_{j2}(q_j^1)$ are then used to determine values for demand, i.e. x_j^0 and x_j^1.

Prediction of the demand for trips is complicated because the demand function was initially estimated using a Tobit procedure. Recall the model underlying the Tobit,

$$x^* = \beta' z + \varepsilon \qquad \varepsilon \sim N(0, \sigma^2)$$

where values of $x^* < 0$ are censored and observed as zeroes, so that

$$x = \beta' z + \varepsilon \qquad \text{when } \beta' z + \varepsilon > 0$$

and

$$x = 0 \qquad \text{otherwise.}$$

Given the underlying model, the systematic portion of (4.4) cannot be used as the expected value 1ocuiy of x, The Tobit predicting equation given below adjusts for the censored nature of the dependent variable:

$$E(x_{ij}) = \Phi\left(\frac{\hat{\beta}'z}{\hat{\sigma}}\right)\hat{\beta}'z + \hat{\sigma}\phi\left(\frac{\hat{\beta}'z}{\hat{\sigma}}\right) \quad (4.13)$$

where z is a vector of explanatory variables and ϕ and Φ are the density and cumulative distribution functions for the standard normal, respectively, The first term represents the conditional expectation of trips given that the person participates times the probability that the person participates. The second term corrects for non-normality because of potential truncation.

There are two ways of obtaining the "before" and "after" x's for the consumer surplus functions. One way is to use the predicting equation (4.13) to calculate both $\hat{x}^0$ and $\hat{x}^1$ values. The second method is to accept the observed x as x^0 and then to adjust this x by $\hat{x}^1 - \hat{x}^0$ to reflect the hypothetical change in water quality to obtain the estimated x^1. (See Bockstael and Strand, 1986, for details of the two approaches.)

Because there is no clear theoretical reason to choose one approach over the other, we calculate the results both ways. Both methods use formula (4.11) to calculate the change in average consumer surplus. However, Method A calculates trip values as

$$\hat{x}^0_{ij} = \Phi\left(\frac{\hat{\beta}^{0\prime}_j z_{ij}}{\hat{\sigma}}\right)\hat{\beta}^{0\prime}_j z_{ij} + \hat{\sigma}\phi\left(\frac{\hat{\beta}^{0\prime}_j z_{ij}}{\hat{\sigma}}\right) \quad (4.14)$$

and

$$\hat{x}^1_{ij} = \Phi\left(\frac{\hat{\beta}^{1\prime}_j z_{ij}}{\hat{\sigma}}\right)\hat{\beta}^{1\prime}_j z_{ij} + \hat{\sigma}\phi\left(\frac{\hat{\beta}^{1\prime}_j z_{ij}}{\hat{\sigma}}\right) \quad (4.15)$$

where the z_{ij} are the explanatory variables in the j^{th} beach's regression (see Table 4.2). Method B calculates the demand for trips in the following way:

$$x^0_{ij} = \text{observed value of } x_{ij}$$

and

$$x^1_{ij} = x^0_{ij} + \hat{x}^1_{ij} - \hat{x}^0_{ij}$$

where $\hat{x}^1_{ij}$ and $\hat{x}^0_{ij}$ are defined in (4. 14) and (4. 15).

Tables 4.3 - 4.5 summarize the average beach users benefits and losses from the hypothetical changes in the nitrogen and phosphorus concentrations in the Chesapeake Bay. The first and fourth columns in each table represent the base line *average consumer* surplus over the entire sample *of* beach users

Table 4.3

Annual Benefits per Beach User from a 20 Percent Decrease in Pollutant, by Beach
1984

Beach	Calculation Method A[a]			Calculation Method B[b]		
	Consumer Surplus Before	After	Benefits	Consumer Surplus Before	After	Benefits
Sandy Point	133.94	169.03	35.09	342.04	379.33	37.06
Fort Smallwood	.82	5.17	4.35	57.69	73.13	15.44
Chesapeake Beach	36.32	43.88	7.56	57.89	60.77	2.88
Rod & Reel Club	10.32	16.19	5.87	259.81	284.08	24.27
Porter's New Beach	5.95	8.45	2.50	12.20	12.34	1.14
Rocky Point	80.38	89.53	9.15	179.65	191.02	11.34
Point Lookout	15.86	22.61	6.75	315.27	415.06	99.79
Bay Ridge	178.18	204.76	26.58	171.64	178.98	7.34
Miami Beach	5.38	'10.27	4.89	220.68	304.99	84.31

[a] With Method A, the average consumer surplus for a change in quality at beach j is taken over a sample which includes all beech users whether or not they visited beach j.

[b] With Method B, the average consumer surplus for a change in quality at beach j is taken over a sample which includes only users of beach j.

Table 4.4

Annual Benefits per Beach User from a 10 Percent Decrease in Pollutant, by Beach 1984

Beach	Calculation Method A[a]			Calculation Method B[b]		
	Consumer Surplus Before	After	Benefits	Consumer Surplus Before	After	Benefits
Sandy Point	133.94	150.39	16.45	342.04	363.35	21.31
Fort Smallwood	.82	1.50	.68	57.69	69.28	11.59
Chesapeake Beach	36.32	39.96	3.64	57.88	61.11	3.22
Rod & Reel Club	10.32	13.00	2.68	259.81	277.73	17.92
Porter's New Beach	5.95	7.12	1.17	12.20	13.55	1.35
Rocky Point	80.38	84.82	4.44	179.65	186.63	6.98
Point Lookout	15.86	18.73	2.87	315.27	363.61	48.34
Bay Ridge	178.18	191.08	12.90	171.46	176.55	5.09
Miami Beach	5.38	7.34	1.96	220.68	261.16	40.48

[a]With Method A, the average consumer surplus for a change in quality at beach j is taken over a sample which includes all beach users whether or not they visited beach j.

[b]With Method B, the average consumer surplus for a change in quality at beach j is taken over a sample-which includes only users of beach j.

Table 4.5

Annual Losses per Beach User from a 2.0 Percent Increase in Pollutant, by Beach 1984

Beach	Calculation Method A[a]			Calculation Method B[b]		
	Consumer Surplus Before	Consumer Surplus After	Losses	Consumer Surplus Before	Consumer Surplus After	Losses
Sandy Point	133.94	106.54	(27.40)	342.04	311.26	(30.78)
Fort Smallwood	.82	.29	(.53)	57.69	47.63	(10.06)
Chesapeake Beach	36.32	29.81	(6.51)	57.88	55.27	(2.62)
Rod & Reel Club	10.32	6.25	(4.07)	259.81	239.35	(20.46)
Porter's New Beach	5.95	4.05	(1.90)	12.20	11.24	(.96)
Rocky Point	80.38	72.26	(8.12)	179.65	166.81	(12.84)
Point Lookout	15.86	11.92	(3.94)	315.27	253.41	(61.86)
Bay Ridge	178.18	154.56	(23.62)	171.64	164.55	(7.09)
Miami Beach	5.38	3.06	(2.32)	220.68	172.41	(48.27)

[a]With Method A, the average consumer surplus for a change in quality at beach j is taken over a sample which includes all beach users whether or not they" visited beach j.

[b]With Method B, the average consumer surplus for a change in quality at beach j is taken over a sample which includes only users of beach j.

for use of each beach, calculated using each of the two methods mentioned above. The second and fifth columns show the average consumer surplus per beach user in the sample following a water quality change at each beach. The third and sixth columns represent the change in surplus for the average beach user associated with a water quality change at each beach.

The method of calculation makes a good deal of difference for some beaches, especially Point Lookout, Miami Beach and Rod and Reel. Recalling the econometric results in Table 4.2, the estimated demand equations for these three are price inelastic relative to other beaches; that is, the absolute values of their price coefficients are quite small. When demand is very inelastic, big differences are likely between the mean consumer surplus and the consumer surplus associated with the mean number of tripe (see Bockstael and Strand).

The average consumer surplus values are expanded to the entire Baltimore-Washington SMSA's in Table 4,6. This was accomplished by knowing that the 1980 number of regional households was 1,977,000 (census of the U. S., 1980), by determining from a contemporaneous phone survey that 47 percent of the regional population used western shore beaches" and by knowing the percentage of western shore beach users who used each beach. Large aggregate benefits are associated with Sandy Point (in both methods of calculation) because of the very large number of households that visit that beach. Whereas 21 percent of the population used western shore beaches, over half used Sandy Point. When expanding to households, Sandy Point has nearly twice as many users as any other beach.

The Discrete/Continuous Choice Model

The utility maximizing model in (4.2) and the resulting demand functions in (4.3) are an apt description of the individual's decision problem only if he chooses positive values for all x_i (i.e., if he is at interior solutions in all the markets). It is not an adequate description if corner solutions arise (i.e., $x_i = 0$). The discrete choice model is appropriate when an individual chooses one from a finite set of alternatives, by comparing the available alternatives. The discrete choice model presented here is amended to include a component which describes the demand for trips as well as the discrete choice among trips on any choice occasion.

The Choice Among Sites

The first part of the model involves the estimation of the household's choice among sites. It will be important here to capture those elements which vary over sites. McFadden (1976) provides a utility theoretic framework for employing the multinominal logit model which is applicable to a discrete choice problem of this sort. For further discussion of its application to recreation demand, see Bockstael, Hanemann and Strand (1986).

Table 4.6

Aggregate Benefits/Losses to Users from Changes in Chesapeake Bay Water Quality, by Beach
1984

	Calculation Method A			Calculation Method B		
	Change			Change		
	Improvement		Degradation	Improvement		Degradation
Beach	20%	10%	20%	20%	10% ,	20%
	. . . . Thousands$.					
Sandy Point	14,064	6,602	(11,001)	9,967	4,704	(8,009)
Fort Smallwood	1,744	275	(212)	1,576	651	(781)
Chesapeake Beach	3,038	1,462	(2,612)	680	329	(597)
Rod & Reel Club	2,356	1,075	(1,632)	1,316	626	(1,089)
Porter's New Beach	1,006	468	(750)	52	24	(40)
Rocky Point	3,673	1,781	(3,258)	923	449	(824)
Point Lookout	2,708	1,153	(1,577)	12,484	5,375	(7,520)
Bay Ridge	10,667	5,176	(9,484)	823	397	(710)
Miami Beach	1,963	788	(931)	3,975	1,674	(2,255)

Suppose we call V_i^* a latent variable denoting the level of indirect utility associated with the ith alternative. The observed variable Y_i has the property that

$$Y_i = 1 \quad \text{if } V_i^* = \max(V_1^*, V_2^*, \ldots, V_M^*)$$
$$Y = 0 \quad \text{otherwise.}$$

Indirect utility associated with the ith alternative is some function of z_i, a vector of attributes of the ith alternative so that $V_i^* = V_i(z_i) + \varepsilon_i$. The random component is generally attributed to the systematic? but unmeasurable, variation in tastes and omitted variables. Thus, each household has a level of error which, in a sense, remains with it over time. If the ε's are independently and identicaly distributed with type I extreme value distribution (Weibull), then it is well known that

$$\text{Prob}\,(Y_i=1 \mid z) = \frac{e^{V_i}}{\sum_{j=1}^{M} e^{V_j}},$$

(see Maddala 1983; McFadden, 1973; Domencich and McFadden, 1975). The likelihood function for the sample is

$$L = \prod_{i=1}^{M} \left[\frac{e^{V_i}}{\sum_j e^{V_j}}\right]^{g_i}$$

where gi = 1 if i is chosen, gi = 0 otherwise.

The multinominal logit has a property which in some circumstances is useful but in others is unrealistic. The model presented above implicitly assumes independence of irrelevant alternatives, i.e. the relative odds of choosing any pair of alternatives remains constant no matter what happens in the remainder of the choice set. Thus, this model allows for no specific pattern of correlation among the errors associated with the alternatives; it denies--and in fact is violated by--any particular similarities within groups of alternatives.

McFadden (1978) has shown that a more general nested logit model specifically incorporating varying correlations among the errors associated with the alternatives can also be derived from a stochastic utility maximization framework (see also Maddala, 1983). If the ε's have a generalized extreme value distribution then a pattern of correlation among the choices can be allowed. McFadden defines a probabilistic choice model

$$P_1 = \frac{e^{V_i} G_i(e^{V_1}, \ldots, e^{V_N})}{G(e^{V_1}, \ldots, e^{V_N})}$$

here G_i is the patial of G with respect to the i^{th} argument and $G(e^{V_1},\ldots,e^{V_N})$ has certain properties which imply that

$$F(\varepsilon_1,\ldots,\varepsilon_n) = \exp\{-G(e^{-\varepsilon_1},\ldots,e^{-\varepsilon_n})\}$$

is a multivariate extreme value distribution. When $G(e^{V_1},\ldots,e^{V_N})$ is defined as Σe^{V_i} then the model reduces to the ordinary multinornial logit (MNL) described above. However when

$$G(Y) = \sum_{m=1}^{M} a_m \left(\sum_{i \in S} e^{V_i/(1-\delta_m)} \right)^{1-\delta_m}$$

where there are M subsets of the N alternatives and $0 \le \delta_m < 1$, then a general pattern of dependence among the alternatives is allowed. The parameters, δ_m, can be interpreted as an index of the similarity within groups.

Suppose we were to classify the alternatives into these M groups where δ_m denotes the set of alternatives in group m, and we were interested in the probability of choosing some alternative i. Then

$$P_i = \sum_{m=1}^{M} P(i|S_m) \cdot P(S_m),$$

where

$$P(i|S_m) = \begin{cases} \dfrac{e^{V_i/(1-\delta_m)}}{\sum_{j \in S_m} e^{V_{jm}/(1-\delta_m)}} & \text{if } i \in S_m \\ 0 & \text{Otherwise} \end{cases}$$

and

$$P(S_m) = \frac{a_m \left(\sum_{j \in S_m} e^{V_{jm}/(1-\delta_m)} \right)^{1-\delta_m}}{\sum_{n=1}^{M} a_n \left(\sum_{k \in S_n} e^{V_{kn}/(1-\delta_n)} \right)^{1-\delta_n}}$$

The above GEV model is useful in many applied discrete choice problems. Frequently, alternatives group themselves in obvious patterns of ability. If they do, it is both convenient and appropriate to estimate the GEV model. It is appropriate because the results of an ordinary MNL will violate the independence of irrelevant alternatives asumption if such a pattern actually exists. It is convenient because it reduces the number of alternatives included at each stage.

Let us make the estimation process explicit. In the problem at hand, individuals are choosing among ten beaches. Two of these beaches are qualitatively different. They are state parks, larger and providing more services than the local beaches. Now we can view the choice problem as a two-level nested one: the choice between state park or local beach (m = 1, 2) and the choice among beaches within each group. Consider a redefinition of V_i:

$$V_{im} = \theta' Z_{im} + \psi' W_m$$

where the Z's denote attributes associated with all sites and the W's are attributes associated with the state park and local beach choice. Also let us assume that δ_m is identical within all groups and equal to δ

Now define a variable, I_m, in the following way:

(4.16)
$$I_m = \ln \left(\sum_{i \in S_m} e^{\theta' Z_{im}/(1-\delta)} \right).$$

Then the probabilities above can be rewritten as

(4.17)
$$P_{i|m} = \frac{e^{\theta' Z_{im}/(1-\delta)}}{\sum_{k \in S_m} e^{\theta' Z_{km}/(1-\delta)}}$$

and

(4.18)
$$P_m = \frac{e^{\psi' W_m + (1-\delta) I_m}}{\sum_{j=1}^{M} e^{\psi' W_j + (1-\delta) I_j}} ,$$

The variable I_m is sometimes termed an inclusive value (see McFadden, 1978) . and serves as an index of the relative value of the alternatives included in subgroup m.

As expressed in (4.17) and (4.18), the probabilities of interest can be estimated using MNL proced urea. First, the $P_{i|m}$ are estimated with M independent applications of the multinominal logit. Note that at this stage θ is not recoverable, but can be estimated only up to a scale factor of $1-\delta$. From the results of (4.17), the inclusive prices (4.16) are calculated and incorporated as variables in the second level of estimation (4.18). Here the ψ's and the δ are estimated.

A δ outside the unit interval is inconsistent with the underlying utility theoretic model and suggests misspecification (see McFadden). The parameter δ is an index of similarity of alternatives within groups not present across groups. A value of one for 15 indicates that alternatives within a group are perfect substitutes. Thus, all relevant choice involves choice among groups. A value of zero for δ implies there is no special similarity *of* alternatives within groups and thus no particular gain from using a nested GEV model.

Two-step estimation, i.e. the estimation *of* (4.17) and (4.18) independently, is not necessarily efficient. Amemiya (1973) explores this property of the model and presents a correction factor. However, even Amemiya suggests that the cost in computational complexity is probably not worth the gains. We consider McFadden's estimation method adequate and use it to estimate a GEV model in the next section.

Estimation *of* the Discrete Choice Among Beaches

The two-tiered discrete choice model considers the individual choosing between two categories of sites (state park and local beach sites) and then choosing among beaches within the desired category. The state park beaches are located at Sandy Point (adjacent to the Chesapeake Bay Bridge) and Point Lookout (at the mouth of the Potomac), whereas the local beaches are defined to include Fort Smallwood, Bay Ridge, Kurtz's Pleasure Beach, Miami Beach, Morgantown Beach, Porter's New Beach, Rod and Reel Club Beach, North Beach and Chesapeake Beach.

In estimating the model, however, the decision among sites within each category is dealt with first. In assessing the available sites within a category on a choice occasion, the household chooses on the basis of certain household attributes in combination with specific site characteristics. These are denoted Z_{ji} and are defined for one model as:

Z_{1i} = access costs in $ to site i, calculated using distance (d_i) from the household's origin to the site[1] ($Z_{1i} = 1.088 + .049*d_i - .000074d_i^2$) plus the entrance fee plus the wages lost from traveling if the individual had directly foregone income to visit the site;

Z_{2i} = access time (in minutes) to site i, calculated using distance from the household'a origin to the site[2] ($Z_{2i} = .7 + .02d_i$);

Z_{3i} = water pollution index for site i (see description page 18);

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[1] Exact formula was determined by regressing reported costs against distance.

[2] Exact formula was determined by 'regressing- reported travel time against distance.

$Z_{.,}$ = the availability of recreational vehicle facilities at site i (0 if not available, 1 if available) times whether the household owned a recreational vehicle (0 if not owned, 1 if owned);

Z_{5i} = the availability of fishing facilities at site i times whether the household owned fishing equipment;

$Z^*,$ = the availability of boat launch facilities at site i times whether the household owned a boat.

The first stage of the estimation is reported in Table 4.7. The results indicate that relatively large monetary and time costs negatively influence the probability of choosing a beach. Water pollution also has a negative influence as does fishing facilities. Presumably, fishing activity draws the household members away from the beach. Boat facilities and recreational vehicle facilities improve the probability that someone owning a boat or RV will attend beaches with facilities for that equipment.

The second tier of the discrete decision involves whether individuals select a state park (with many activities) or a local beach. The factors hypothesized to be important in deciding to visit a state park were thought to be the years the household had visited western shore beaches (WI), whether the intercepted household had more than one family member in the party (W_2), the size of the group intercepted (w,) and the inclusive value (I_m) derived from the first-stage estimation. People with a larger history of beach use in the area would be more likely to learn of the smaller beaches and hence be less likely to use the state parks. On the other hand, the state parks usually offer a greater variety of activities, and thus families and large parties might be more likely to attend them.

The results of the estimations are presented in Table 4.8. The hypotheses about the choice between state parks and local beaches were not rejected. Signs of coefficients were as expected and coefficients statistically significant.

The estimated coefficient on the inclusive value term is .152 yielding an estimate of .848 for δ. This is significantly different from zero suggesting that there are gains from using the nested model.. There is considerably more similarity among beaches within the two categories than *across* the categories. Had the nested model not been used, the independence of irrelevant alternative assumption would certainly have been violated. The estimate of δ is also significantly different from one, suggesting that beaches within groups, although similar, are not perfect substitutes,

Table 4.7
Logit Regression for Selection Among Sites

Estimate	Access cost Z_{1i}	Access Time Z_{2i}	Water Pollution z,{	Recreational Vehicle z, i	Fishing Activity Z_{5i}	Boat Facilities Z_{6i}
	Variable					
Coefficient (t-statistic)	-.072 (-5.30)	-*75 (-8.63)	-.00037 (-4.00)	1.06 (1.93)	-2.09 (-5.28)	1.14 (2.10)

= 311.2

Table 4.8
Logit Analysis for Selection Between State Parks and Local Beaches

Estimate	Inclusive Value I_m	Years Attending Western Shore Beaches W,	Family Members W_2	Party Size W,
	Variable			
Coefficient (t-statistic)	.152 (9.26)	-.019 (-8.34)	.261 (4.85)	.024 (12. 79)

Chi-squared = 28.07

The Number of Trips Decision

There is no operational model that generally treats utility maximization with non-negativity constraints (Bockstael et al., 1986, Chapter 8),. There exists no utility theoretic means of linking the discrete choice model of site choice on each choice occasion to a continuous choice model of demand for trips (i.e., demand for choice occasions.)

When one decides to use a nonclassical continuous demand function for the demand for recreational trips (irrespective of site), a problem immediately arises in determining the appropriate choice of explanatory variables. Since costs and quality vary across sites and since individuals are observed choosing more than one site in a season, which site's price and quality should be included?

The approach taken here is to consider the number of trips to western shore beaches as a function of a number of explanatory variables and an inclusive value type variable calculated from the second stage of the discrete choice model. This was originally suggested by Hanemann (1978) and was used in Bockstael et al. (1986). Thus when water quality changes, the inclusive value changes and influences the number of trips. In this sense, "the discrete and continuous decisions are linked , although not in a utility theoretic way. The discrete/continuous choice model has the advantage of emphasizing the substitutability of sites but does appear to underestimate the response of demand for trips to changes in cost and quality at one or more sites.

Based on the results of the discrete choice estimations, a new inclusive value (In) which includes the factors in the choice among sites and the choice between state parks and local beaches is calculated. This value, along with the individual's income (INC, income or full income if at interior in the labor market), discretional y time available (DT, if at corner in the labor market) and the number of trips to western shore beaches in the previous year (x_{t-1}), is used to estimate the 1984 total number of trips per household to western shore beaches (x_t).

The higher an individual's inclusive value, the more attractive are his beach alternatives (e.g. good beaches are cheaper to get to) and the more trips he is likely to take. Additionally, beach use habits (as reflected in previous trips) would likely lead to more trips. Whether income and discretionary time positively or negatively affect the number of trips depends on whether a day trip to western shore beaches is a normal (positive effect) or inferior (negative effect) good.

The results of an ordinary least squares regression are given in Table 4.9. The expected signs occur, and the results indicate a western shore trip is an inferior good, both with respect to income and time. The predictive powers of the equation are especially good considering the cross-sectional nature of the data.

Table 4.9
ordinary Least Squares Regression for "Choice Occasions" or Trips

Estimate	constant	Inclusive Value I_N	Lagged Trips X_{t-1}	Income INC	Discretionary Time DT
Coefficient	.442	4.06	.516	-.028	-.981
(t-statistic)		(2.92)	(8.70)	(-2.79)	(-4.80)

$R^2 = .35$
F-value (4,253) = 36.30

Estimated Benefit Changes

The ultimate purpose of the modelling effort is to estimate the benefits associated with improvements in water quality. Formulas for deriving welfare measures in the context of discrete choice models of random utility maximization have been developed by Hanemann (1982, 1984). It is generally the compensating and/or equivalent variation of the quality change which is taken as a useful measure of benefits. Selecting the compensating variation (C), this measure can be defined by the following expression:

$$v(p^0, q^0, y) = v(p^0, q^1, y - c)$$

where again v is the indirect utility function, p and *q* are vectors of site prices and qualities, and y is income.

The compensating variation is *now* defined by

$$v(p^0, q^0, y; \varepsilon) = v(p^0, q^1, y - C; \varepsilon),$$

where ε is random, and as a result C is now a random variable. Depending on how one chooses to take account of this randomness, three different measures of compensating variation can be defined. In the case of GEV models the median value of C coincides with the C which equates the expected values of the indirect utility functions (Hanemann, 1978). It is this measure which we calculate in the subsequent illustration.

In our problem, using the previous notation,

$$G\left(e^{v_1}, \ldots e^{v_N}\right) = \left(\sum_{j \in J_s} e^{v_j/(1-\delta)}\right)^{1-\delta} + \left(\sum_{j \in J_1} e^{v_j/(1-\delta)}\right)^{1-\delta}$$

where J_s is the set of state park sites and J_l is the set of local beach sites; where $v = \theta' Z_{im} + \psi' W_m$; Z_{im} are factors which vary over sites; and W_m are factors which vary between state park and local beach sites. Thus

$$G\left(e^{v_1}, \ldots, e^{v_N}\right) = \sum_{s=1}^{2} e^{\psi' W_s + (1-\delta) I_s}$$

where

$$I_s = \ln\left| \sum_{i \varepsilon s} e^{\theta' Z_{is}/(1-\delta)} \right|.$$

Then the expected value of the indirect utility function equals

$$v(w^o, z^o, y) = \ln G(e^{v_1^0}, \ldots, e^{v_N^0}) + k,$$

where k is a constant.

Now consider a change in quality which causes w^o and z^o to change to W^1 and z^1. The compensating variation measure (C′) defined above is given by

$$v(w^o, z^o, y) = v(w^1, z^1, y-C')$$

or

$$\ln G\left[e^{v_1^0(y, z^o, w^o)}, \ldots, e^{v_N^0(y, z^o, w^o)}\right]$$

$$= \ln G\left[e^{v_1^1(y-C', z^1, w^1)}, \ldots, e^{v_N^1(y-C', z^1, w^1)}\right]$$

There is no closed-form solution for compensating variation in this case, but Hanemann (1982) shows that the compensating variation per choice occasion of this change *can be* approximated as:

(14) $$\Delta CS = \frac{\sum_{j \varepsilon J} e^{v_j^0} - \sum_{j \varepsilon J} e^{v_j^1}}{\sum_{j \varepsilon J} \gamma_j e^{v_j^1}}$$

where the set J includes the two cases: state and local beaches, γ is the element of the • vector which serves as the price coefficient, and $v_j^q = \psi' w_j^q + (1-\delta) I_j^q$. To expand to annual welfare change, this value is multiplied by the number of choice occasions estimated in the continuous choice model.

These equations were used to estimate the benefits from hypothetical water quality changes. To be consistent with the varying parameters model estimates, we considered a 20 percent reduction and a 20 percent increase in water pollution. The values associated with the changes are $1.08 per trip and $4,70 per household user of western shore beaches. Given that 20 percent of the households used western shore beaches (about 401,000 households), the total gains from a 20 percent improvement in water quality were estimated to be nearly $2 million annually. The estimated loss for a 20 percent degradation was approximately the same.

Discussion

Reiterating, the purpose for our work was to offer benefit estimates based on different methods so as to provide a range of reasonable values. The two models derive from two different conceptualizations of the recreationalists' decisions. The continuous, neoclassical model (represented here by the varying parameters model) is strictly correct only if interior solutions characterize demand for each site, with all individuals attending all sites, Another drawback of this model is that, because of the econometric functions estimated, total benefits cannot legitimately be added across sites. This sort of aggregation provides upwardly biased results.

The discrete/continuous choice model, on the other hand, begins by emphasizing the corner-solution nature of the decision on each choice occasion. Thus, the substitutability among sites receives special attention. The decision about number of trips per season is not well integrated into the estimation process. These models tend to provide low estimates of aggregate benefits because the effect of water quality improvements on demand for trips is not well accounted for by the ad hoc inclusive value variables in the trips equation.

The estimated benefit change resulting from changes in Chesapeake Bay water quality at the western shore beaches is presented in Table 4.10 for the two models. Predictably, the varying parameter model offers the largest change.

Table 4.10
Comparison of Benefits Based on a Varying Parameter Model and Discrete/Continuous Choice

Model	Change	
	20 Percent Improvement	20 Percent Degradation
	---- -- - -(in thousands) -- ---- -- -	
Varying Parameter upper bound	$26,160	- $25,839
Discrete/Centinuous Choice	$ 1,885	- $1,884

Chapter 5

Recreational Boating and the Benefits of Improved Water Quality

Boating is an especially important part of any study of Chesapeake Bay recreation. As the second most popular recreational activity in our telephone sample of Bay users (second only to beach use), 34 percent of the area's households participated in boating activities on the Chesapeake in 1984. This represents nearly three-quarters of the houeeholdo who used the Bay for recreational activities. Its importance is further supported by the large number of registered boats in Maryland (as many as 134,000 in 1981) and by the fact that of the approximately 15 million Person-trips taken on boats in Maryland waters in 1979, 90 percent (or 13.5 million) were taken on estuarine waters of the Bay or its tributaries (Harmon and Associates, 1983).

In this chapter we examine the behavior of Chesapeake boatetrs and estimate the value to boaters from improved water quality. Since no new survey could be initiated for this purpose, the data upon which the analysis rests are drawn from a 1983 boat owners survey which waa made available by the Sea Grant Program and the Department of Recreation at the University of Maryland.

A Profile of Boaters and Boat Owners

The Boat Owners Survey

In 1983 a survey of boaters was sponsored by the University of Maryland Sea Grant Program and the Maryland Coastal Zone Management Program. It consisted of a mail survey of 2515 registered boat owners in Maryland. The design of the sample provided equal representation to owners of boats kept in slips and owners who trailered their boats. The questionnaire, which sought a variety of information about the household and ita boating activities, achieved a response rate of approximately 70 percent.

The boat owners' survey provides different but complementary information to the telephone survey conducted by RTI and described in Chapter 3, as it samples a different population and uses a different sampling scheme. The Sea Grant survey draws only from the population of registered boat owners. From the telephone survey, which is a random sample of the population, we can identify not only those who own boats but also those who uae the Bay for boating whether they own a boat or not. The telephone survey provides information about non-boaters, as well. It does not, however, provide detailed information about boating behavior. Consequently, it is the boat owner survey which will provide most of the data for analysis.

Boaters and Boat Owner Characteristics

Information from both th boat owner survey and the random telephone survey helps describe boating in Maryland. For example, a comparison of those households in the telephone survey who reported that they used the Bay for boating with those who did not revealed no significant differences in family size or years lived in the area but did suggest considerable differences in income and race (ace Table 5.1). The average of boaters' incomes waa significantly higher than the non-boaters' average, and a significantly higher percentage of boaters were white. Interestingly, this significant difference in income appears in the Prince Georges/Anne Arundel/Calvert Counties area (southeastern region) but not in Northern Virginia/Montgomery Count y (western region) or in the Baltimore area (northern region). Likewise, when broken down by subarea the difference in racial composition appears evident in the southeastern and *western* subareas but not in the northern subarea.

Some information can be extracted from the telephone survey about boat ownership as well. Once again *average* family size and years in the area were not *significantl y* different over the two groups, but average income and the racial composition of the sample were (see Table 5.2).

The design *of* the boat owners survey permits a distinction to be drawn between individuala who trailer their boats and those who keep their boats in the water during the season (either at marinas, docks or moorings). The distinction between individual in these groups is important to establish, since the decisions they face are quite different and their behavior must be analyzed separately. Additionally, we shall see that *profiles of* both boats and owners differ somewhat between the two groups. The sampling design was stratified to contact approximately equal numbers from the two groups. Of those who returned questionaires, 718 trailered their boats and 788 kept their boata in the water during the season.

Some interesting features of these two groups are presented in Table 6.3. By far the most common type of boat in the trailered boat sample is• runabout. For obvious reasons, the sample of trailered boats contains very few with cabins (4 percent). It also contains few sailboats (only 6 percent), but this is not a representative figure, since sailboats which do not use auxiliary motors are not required to register in Maryland and thus would not be part of the population sampled. Of boats kept in the water, runabouts (at 33 percent) remain the single moat common class and sailboats (at 31 percent) represent a close second. Once again sailboats with no auxiliary power are likely to be under-repreaented in the sample. However, this distortion will affect the trailered group more, as the boats kept in the water are larger and more likely to have auxiliary engines. Combining cabin cruisers and cruising sailboats, half the boats in the non-trailered sample are cruising boats presumably outfitted for more than one-day trips.

Aa the difference in the type of boat *in* the two groups suggests, the average size and the average value of boats kept in the water are significantly larger than the averages for trailered boats. Additionally, the average income of boat owners in the two groups is significantly different, with trailered boat owners having *on* average lower incomes.

Returning to the telephone survey which provides data on boaters and not just boat owners, we can learn something about the geographical distribution

Table 5.1

Average Characteristics of Boaters and Non-Boaters
in BaMmore/Washington SMSA, 1984
from random telephone survey

	Boaters	Non-boaters
Average Family Size	3.31	3.47
Average Years Lived in Area	29	26
Average Household Income[s]	$46,858	$37,063
By Area:		
Northern Va. /Montgomery Cty., Md.	$50,576	$41,471
Prince George's, Anne Arundel, Calvert Ctya. , Md.•	50, 2s8	28,083
Baitimore County	41,824	38,211
Percent White[a]	88%	74%
By Area:		
Northern Va./Montgomery Cty. , Md.•	97%"	77%
Prince Georges, Anne Arundel, Calvert Ctya. , Md.[a]	83%	64%
Baltimore County	87%	80%

[a]Means of two samples are significantly different at 99% level
source : Telephone Survey, Research Triangle Institute, 1984

Table 5.2

Average Characteristics of Boat Owners and Non-Boat Owners
in Balttmore/Washington SMSA, 1984

	Boat owners	Non-boat Owners
Average Family Size	3.67	3.27
Average Years Lived in Area	28.6	28.2
Average Household Income[a]	$56,511	$40,931
Percent White[a]	94	81

[a]Means of two samples are significantly different at 99% level.
Source: Telephone Survey, Research Triangle Institute, 1984.

Table 5.3
Characteristics of Boats and Boat Owners
from Boat Owners' Survey, 1983

	Trailered Boats	Boats Kept in Water
Total number responding to question of where boat kept	718	788
By boat type		
Runabout	445 (63%)	251 (33%)
Cabin Cruiser	23 (3%)	182 (24%)
Cruising Sail	4 (1%)	199 (26%)
Day Sail	32 (5%)	38 (5%)
Workboat	124 (17%)	38 (5%)
Houseboat	1 (<1%)	13 (2%)
Rowboat	47 (7%)	25 (3%)
Other	35 (5%)	22 (3%)
NA	7	20
Used boats for swimming at least sometimes	360 (51%)[a]	555 (73%)[a]
Used boats for swimming usually or always	133 (19%)[a]	235 (16%)[a]
Used boats for swimming always	41 (6%)[a]	41 (5%)[a]
Used boats for fishing at least sometimes	656 (94%)[a]	582 (76%)[a]
Used boats for fishing usually or always	502 (72%)[a]	290 (38%)[a]
Used boats for fishing always	302 (43%)[a]	107 (14%)'
Average Income of Owner[b]	$38,000	$51,000
Average Current Boat Value[b]	$14,000	$25,000
Average Boat Length[b]	16 feet	23 feet

[a]Numbers in parentheses are percent of those answering question in each stratified sample who gave this response.
[b]Means of two stratified samples are significantly different at 99 percent level.

Source: Maryland Boat Owners Survey, 1983

of households interested in this activity. The geographical distribution of boaters within the state tells us something about the importance of thie activity to different population subgroups. From the telephone survey it is clear that boating is an important activity to Maryland residents throughout the state; it is the first or second moat popular recreational activity on the Bay in each of the geographical •ubareaa of the study. However, as might be expected, boaters are moat commonly residents of counties contiguous to the Bay. A good example is the large proportion of Anne Arundel residents who participate in *boating.* Extrapolating *from* our survey suggests that almost half of the households in Anne Arundel County had at least one member who went boating on the Bay in 1984.

Table 5.4 contains residence data gleaned from the boat owners survey for boat owners, by trailered and nontrailered classes. The values shown in this table indicate the distribution of residence counties among those who responded to this question in the boat owners survey. Of those who reported residence, 64 percent *of* each group lived in counties contiguous to the Bay. Approximately 60 percent of the respondents came from the four most populated counties in the state - Baltimore, Anne Arundel, Montgomery and Prince Georges. A final interesting feature of the sample is that about 5 percent of the respondents lived out-of-state even though they registered their boats in Maryland.

The fact that boating is often the vehicle for other Bay recreational activities makes the analysis of boating both important and complex. The incidence of multiple activities is critical because participation in the complementary activities of swimming and fishing may make boaters more sensitive to water quality. Additionally, the overlap of activities complicates benefit estimation when benefits are aggregated over activities.

From the boat owners' survey we can learn something about the importance *of* these multiple activity trips. Table 5.5 reports frequencies *of* responses to questions regarding these complementary activities. One striking feature of these answers is that fishing is extremely important to those registered boat owners who trailer their boats. In fact almost *all* (94 percent) of the trailered boat owners who responded to the question indicated that they fished at least occasionally from their boats, and almost half (43 percent) claimed to fish on every trip. Fishing was less important among the non-trailered boat owners, although three-quarters of them indicated that they fished from *their* boats at least Occasionally. About the same percentage of this group indicated they sometimes ueed their boats for swimming. Fewer, about half, of the trailered boat owners sometimes used their boats for swimming.

Table 5.4
Number of Trailered Boats and Boats Kept in the Water,
By Residence, 1983.

	Trailered Boats		Boats Kept in Water	
Residence				
Baltimore		162 (24%)[a]		144 (20%)
Anne Arundel		99 (15%)		184 (25%)
Montgomery		64 (9%)		60 (8%)
Prince George's		71 (11%)		28 (4%)
Calvert	17 (3%)		14 (2%)	
St. Mary's	25 (4%)		25 (3%)	
Charles	23 (3%)		7 (l%)	
Lower Western Shore - Total		65 (10%)		46 (6%)
Cecil	12 (2%)		11 (1%)	
Harford	27 (4%)		20 (3%)	
Kent	7 (1%)		5 (1%)	
Upper Bay - Total		46 (7%)		36 (5%)
Dorcester	8 (1%)		9 (1%)	
Queen Anne	13 (2X)		12 (2%)	
Somerset	5 (1%)		2 (<1%)	
Talbot	9 (1%)		30 (4%)	
Wicomico	21 (3%)		9 (l%)	
Eastern Shore - Total		56 (8%)		62 (8%)
Carol ine	7 (1%)		2 (<1%)	
Worcester	10 (1%)		9 (l%)	
Carrel	11 (2%)		4 (1%)	
Allegheny	0		3 (<1%)	
Frederick	16 (2%)		7 (1%)	
Garrett	0?		5 (1%)	
Howard	19 (3%)		14 (2%)	
Washington	20 (3%)		6 (1%)	
Other - Total		83 (12%)		50 (8%)
Pennsylvania		13 (2%)		67 (9%)
Virginia		10 (1%)		36 (5%)
District of Columbia		6 (l%)		18 (2%)
Not Identified		43		57
TOTAL		718		788

[a]Numbers in parentheses represent percent of those answering questions in each stratified sample who gave this response.

Source: Maryland Boat Owners Survey, 1983

Table 5.5

Percent of Boaters Who Fish or Swim While Boating
Boat Owners' Survey, 1983

	Occasionally	Usually	Always	At Least Occasionally[a]
Trailered boats:				
Fish while boating	22%	29%	43%	94%
Swim while boating	33%	13%	6%	52x
Non-trailered boats:				
Fish while boating	38%	24%	14%	76%
Swim while boating	42%	25%	5%	72%

● Total of other columns
Source: Maryland Boat Owners Survey, 1883

The importance of Water Quality to Boaters

It is useful to consider the qualitative evidence that exists to support the notion that water quality does in fact matter to boaters. Some evidence to this effect can be found in the 1983 boat owners survey. Tables 5.6 and 5.7 present a compilation of responses to a series of questions about factors important in the selection of boating areas. As can be aeon from these tables, boat owners who trailered their boats considered water quality to be the moat important factor in choosing boating areas Water quality waa considered "very important" or at least "moderately important" by the non-trailered boat owners more often than any other factor except water depth. The latter is often a physical constraint for the larger boats found in marinas. Comparing the two subgroups, i.e. those who considered water quality "moderately" or "very" important and those who did not, it is interesting to note that the former had on average significantly higher incomes and more valuable boats.

The Behavior of Boat Owners Who Trailer Their boats

The General Model

We are interested in modelling two types of decisions that owners of trailered boatS make in a season. One of these is the commonly modelled economic decision of how many trips the individual takes. The second haa to do with the location to which the boat owner takes his boat. This subgroup of boat owners is far more flexible in the short run than those who keep their boats in the water during the season, because on a day to day basis they can

Table 5.6 Factors Cited Most Important
in the Selection of a Boating Area in Maryland, 1983

Percent Response from 718 Boat Owners Who Trailer Their Boats

Factor	Not Important	Slightly Important	Moderately Important	Very Important	No Response
Water Quality	11.1	9.3	33.0	42.2	3.1
Water Depth	16.3	13.2	29.5	36.4	3.3
Natural Beauty	15.7	17.5	34.0	28.1	4.6
Easy Access	13.8	20.1	35.7	26.7	3.8
Lack of Congestion	19.5	16.7	32.0	27.4	4.3

Source: Maryland Boat Owners Survey, 1983

Table 5.7 Factors Cited Moat Important
in the Selection of a Boating Area in Maryland, 1983

Responses from 788 Boat Owners Who Keep Their Boats in Marinas

Factor	% Not Important	% Slightly Important	% Moderately Important	% Very Important	% No Response
Water Depth	7.7	8.9	24.4	54.9	4.1
Water. Quality	9.3	10.0	35.7	39.7	5.3
Natural Beauty	9.8	13.3	41.0	31.2	4.7
Protected Anchorage	23.5	15.1	31.5	25.1	4.8
Lack of Congestion	19.9	17.4	37.2	20.4	5.1

Source: Maryland Boat Owners Survey, 1983

alter the boating area by trailering to different launch sites. Of course, the farther they must trailer the boat, the more costly (in both time and money) will be the trip. Responses to the survey indicate that factors besides costs are important in choosing boating area. Specifically, water quality was considered the moat important factor in this choice, Thus we analyze the demand for trips to different sites with measurably different water quality. This gives us some basis to deduce how demand might change if water quality were to change at different sites.

In order to accomplish this, a model of multiple site demand is designed to accommodate differing qualities across sites but to require no more data than is available from the boat owners' survey and Chesapeake Bay water quality data. Given these limitations and a desire for consistency of analysis across recreational activities, the varying parameters model presented as the first method of analysis in Chapter 4 is used.

The model takes the *following* form. The demand for trips to each site j is estimated as a function *of* the coat to individual i of accessing the site (c_{ij}), substitute site ace-a costs (s_{ij}), and other exogenous variables associated with the individual (s_i):

$$(5.1) \qquad x_{ij} = f_j(c_{ij}, s_{ij}, z_i; \beta_j) \qquad \text{for all } i,$$

where f_j is the demand function for the j^{th} site, β_j is the vector of parameters in each of the site demand functions to be estimated.

Equation (5.1), which is the first stage of the varying parameters models, can not be estimated using ordinary least squares methods. The sample upon which the estimation is baaed includes a large number of zero values for the dependent variable. As described earlier in this volume, ordinary least squares applied to censored samples will produce biased estimators. As described in the last chapter, Tobit estimation procedures are used to correct for the problem.

The second stage of the model relates the set of β parameters in the site demand functions to the site water quality characteristics (a vector w_j). In this way the demand for a site is implicitly modelled as a function 'of the site's characteristics. The second stage model is *of* the form:

$$(5.2) \qquad \beta_{kj} = g^k(w_j) \qquad \text{for all } j,$$

where k indexes the specific β coefficient within the demand equations and j indexes the site demand. Again the application of ordinary least squares is not optimal. The above model likely suffers from heteroskedasticity (see Desvousges, Smith, and McGivney, 19S3) which will produce Inefficient estimators. To correot for the expected heteroskedasticity, the entire equation can be multiplied by the reciprocal of the standard error *of* the respective estimated Coefficient Thus, if σ_{kj} is the standard *error* of the estimated coefficient β_{kj} *from* the Tobit estimation Of the demand *for* site j, then the second stage model corrected for heteroskedasticity can be written

$$(5.3) \qquad \beta_{kj}/\sigma_{kj} = g^k(w_k/\sigma_{kj})$$

for each of the k=1,...,K β coefficients from the first stage.

The Data

The arguments of equation (5.1) which were determined to be relevant for the analysis include the coat of access to the site, the coat of access to a substitute site, and the value *of the* boat. The latter variable waa chosen as a surrogate for two very important factors. Boat value and income are highly correlated , so boat value serves as a surrogate for income level, a variable which is normally rather difficult to obtain with accuracy. Boat value alao will be highly correlated with boat sise which haa an *effect on the site* choice. Since boat length and income are correlated, including them separately in the equation produces unresolvable multicollinearity.

The coat of access variable is the roundtrip cost, including time coat. Costs vary across boaters for several reasons. Obviously the county of origin influences costs, for the further the county is *from* the launch site, the higher the coat of travel. The cost variables include time costs, computed as one-half the individual's average hourly wage (income/2080) time. the distance traveled divided by 40 miles per hour. Finally the money cost of trailering a boat depends on the size of the individual's boat. The coat per mile of trailering a boat was estimated, using coat and boat length information from the data set, as -.78 + .08 *(boat length). The final coat variable includes the toll for the Bay Bridge, when relevant.

To calculate the substitute cost, the above formula waa applied to the closest cite not chosen. While a vector *of* costs *to* all alternative sites might be considered preferable, there are several practical problems with including such a vector in the regression, espicially severe multicollinearity.

Not all observations on boat owners who trailered their boats were ueed because *of* heterogeneity of respondents and incomplete data. Observations were deleted if the individual did not use his boat for any trip. in 1983 or if he did not report launch sites or location of residence. Additionally, those who reporeted their residence to be a distant state, precluding day trips to the Bay, were deleted. Finally, to make the sample relatively homogeneous, sailboats were excluded from the analysis. The latter accounted ultimately for only seventeen deletions. The final sample included 408 observations.

The above information. waa obtained from the boat owners' survey. However, this data source dose not include any information about either perceived or measurable water quality at various sites. Once again the Chessie system provided the *environmental data,* and the environmental quality variable used was the product of nitrogen and phosphorus, as in Chapter 3.

The Estimated Model

For the first stage of the model, the parameters in the following functional form are estimated:

$$x_{ij} = \beta_{0j} + \beta_{1j} c_{ij} + \beta_{2j} s_{ij} + \beta_{3j} b_i + \varepsilon_{ij} \qquad (5.4)$$

where x_{ij} is trips to site j, c_{ij} is cost to site j, s_{ij} cost to next best alternative to site j, and b_i is boat value, all for individual i.

The first stage results for each of the twelve sites are presented in Table 5.8, The results are remarkably consistent across sites. The own price coefficients are all negative and significantly different from zero at the 99% level of confidence. Substitute price coefficients are universally positive and significantly different from zero for eight of the twelve sites. The coefficient on boat value is significantly different from zero *for seven of the* sites and in each of theaa cases haa a positive sign, suggesting that wealthier people and/or people with bigger boats take more boating trips, ceteris paribus.

Demand is relatively inelastic with respect to substitute price and boat value (i.e. a 1 percent change in either of these causes a less than 1 percent change in the demand for trips), However, the demand for trips to a site is quite elastic with respect to the cost of accessing the site, with own price elasticity *ranging* from -1.5 to -7.0.

In the second stage, there are as many equations as there are parameter from the first stage which we wish to allow to vary with the environmental factors. Since we have no particular a priori *information as to* what parameters might vary, we can model each as a function of the environmental variables and allow the test statistics to determine the outcome.

The second stage model is given by

$$\beta_{kj} = \alpha_0 + \alpha_1 \, TNP_j + \nu_j \qquad (5.5)$$

and the results are presented in Table 5.9. The product of nitrogen and phosphorous serves as the environmental variable. The regression of the own coat coefficients from the linear first stage model on these environmental variables produced good results. The coefficient is significantly different from zero and negative. The negative sign suggests that the demand curve becomes less steep with increasing levels of pollutant.

Neither the constant term nor the coefficient on boat value yielded significant second stage results. Even though the coefficient of substitute price waa associated with a significant negative coefficient on the environmental variable, allowing this coefficient to vary had no appreciable effect on the welfare results. As a consequence, in the remainder *of* the analysis we allow only the coefficient *on own* price to vary wtth environmental quality. The results suggest that an increase in pollution would tend to have the effect *of* pivoting inward the demand for trips to the site.

TABLE 5.8

Estimated Tobit Demand Coefficients: Maryland Counties 1983

county	Estimated Coefficients (Variable)[a] $\hat{\beta}_1$ (cost/ trip)	$\hat{\beta}_2$ (substitute cost/trip)	$\hat{\beta}_3$ (boat value 1000's)	$\hat{\beta}_0$ (constant)	non-limit observa-tions
Anne Arundel	-.13 (8.75)[b]	.03 (3.42)	1.29 (5.94)	-2.21 (1.61)	142
Baltimore	-.43 (9.21)	-.02 (1.13)	1.78 (4.01)	-1.94 (.77)	75
Calvert	-.14 (4.14)	.08 (13.70)	1.84 (3.45)	-27.14 (7.21)	44
Cecil	-.22 (4.84)	.04 (1.54)	2.12 (3.09)	-16.44 (3.87)	17
Charles	-.34 (8.41)	.07 (3.77)	2.75 (6.79)	.49 (.19)	38
Dorchester	-.09 (2.86)	.08 (2.69)	.66 (.78)	-34.38 (6.68)	30
Harford	-.15 (5.55)	.05 (2.63)	1.51 (1.67)	-12.21 (3.74)	36
Kent	-.25 (4.94)	.11 (3.57)	.14 (.14)	-18.25 (3.45)	28
Queen Anne's	-.27 (6.17)	.07 (2.88)	.12 (.19)	-3.83 (1.03)	36
St. Marys	-.11 (6.40)	.05 (3.12)	1.25 (2.94)	-9.46 (3.31)	67
Somerset	-.12 (4.76)	-.03 (.58)	2.81 (3.13)	-37.20 (6.64)	24
Wicomico	-.15 (6.93)	.05 (1.58)	1.02 (1.71)	-7.03 (2.02)	26

[a]Each equation is estimated with the 496 boaters who trailer their boats.
[b]Absolute values of t-statistics in parentheses

Table 5.9

Estimation Results from Second Stage

	Constant	TNP
Regression of trip coat coefficient	-.0887 (4.29)[a]	-.000102 (3.54)
Regression of substitute cost coefficient	.0682 (7.47)	-.000016 (1.78)
Regression of constant	-19.414 (4.14)	.007338 (1.93)

● absolute values of t-statistics in parentheses

Modelling the *Behavior of* Boat Owners Who Do Not Trailer Their Boats

Boat *owners* who keep their boats in the water during the season *are far* more restricted in the short run as to the quality of the water that they can easily enjoy. To *alter* the area in which they boat they must take long trips in their boats or they must change mooring arrangement. We do not have access to information that would allow us to model either of these decisions. None *of* our data allows us to observe these individual making trade-offs between water quality and other goods *or* money. As a consequence we can not deduce from observations on their behavior how they might value improvements in water quality.

What we can do however is to learn something about their demand for boating and their use of the Chesapeake, which in itself is useful information *for* the policy maker. In this section we estimate the demand for boating trip. by boaters who keep their boats in marinas. Since we are interested in the short run decision of how many tripe to take, the relevant cost variable is the variable coat of *a* trip. Given the information available, we can approximate the money and time costs *of* travel to the marina. Explanatory variables which may shift the demand function include income and the size (or value) *of* the boat.

The boats in the marina subgroup are somewhat heterogeneous. For *one* thing, about half are sail boats and half are *motor* boats. Consequently we might wish to teat whether the demand functions *for* the two groups are significantly different.

The results *of* thin analysis are reportad in Table 5.10. The coefficient on coot is negative, as expected, and significantly different from zero. The coefficient on boat value is positive, indicating that, all else equal, boaters with more expensive boats take more trips. Income appears not to *affect* systematically the demand for trips.

Table 5.10

Estimated Demand for Boating Trip.
Boats Kept in Marinas

Explanation Variable	Coefficient	t-statistic
Cost	-1.046	-3.93
Boat Value ($1, 000)	.357	1.94
Income ($1,000)	.148	.66
Sailboat Index[a]	-23.596	-2.27
Cost Sailboat Index	.615	2.16
Constant	63.363	6.66

R^2 = .109
# of Observations = 240

•Variable equals 1 if boat is sailboat, O otherwise

Both the constant term and the cost coefficient shift significantly for individuals who own sail boats. The demand function for non-sail boat trips is given by

TRPS = 63.36- 1.05 coat + .36 boat value + .15 income

where boat value and income are in thousands of dollars. The sail boat demand for trips is given by

TRPS = 39.77- .43 cost + .35 boat value + .15 income.

At the same cost and boat value, sailboat owner. demand fewer trips, and their demand for trips appears to be rim-e inelastic.

Because of the eventual need to aqgregate behavior over recreational activities, it would also be useful to know whether those boaters who ● penal a large portion of their time fishing have significantly different demands from those who do not. These results are presented in Table 15.11. It appears that the two groups demands are different. For any given cost and boat value, fishermen demand more trips and their demand tends to be more elastic. Fishermen}. demand is given by

TRPS = 73.61- 1.32 coat + .35 boat value + .15 income

and demand by non-fishermen is

TRPS = 43.00- .51 cost + .35 boat value + .15 income.

Table 5.11

Estimated Demand for Boating Trips, Fishing Behavior
Boats Kept in Marinas

Explanatory Variable	Coefficient	t-statistic
Trip Coat	-.506	-3.86
Boat Value ($1,000)	.350	1.90
Income ($1,000)	.148	.88
Fishing Index[a]	30.535	2.8s
Coat Fishing Index	-.815	-1.82
Constant	43.085	3.81
R^2 = .116		

● Variable equals 1 if boater fishes on boating tripe "usually" or "always," O otherwise.

calculating Estimates of the Benefits of Water Quality Improvements for the Trailered Boat Samle

Because we have bean able to estimate the demand for boating trips by boaters who trailer their boats to different areas as *functions of* costs and the water quality in those areas, we can estimate welfare gains and losses from water quality changes to this group. Unfortunately no observable behavior of the boaters who keep their boats in the *water* allows us to deduce anything about the value they place on improved water quality.

As in the previous chapter, three different changes in the environmental variables are considered. In one caae we impose a 20 percent decrease (environmental improvement) in the environmental (pollution) variables. Subsequent experiments include a 10 percent decrease and a 20 *percent* increase (environmental degradation).

Additionally, two different calculation procedures are provided, identical to those used With the varying parameters model in Chapter 4. The two methods of calculating "before" and "after" trip demands yield two sets of average consumer surplus estimate. before and after the environment change and, consequently, two sets of benefit (or leas) estimates due to the environmental change. (A description of these methods can be found in Chapter 4.) The estimates are reported in Tables 5.12? 5.13, and 5.14 for the 10 percent improvement 20 percent improvement and 20 percent deterioration in the water quality variable, respectively. The average consumer surplus figures are per boater (trailered boats, only) per season for the designated site. Thus the first entry in Table 5.12 is an estimate of the value of access to sites in Anne Arundel County per boater in the sample.

In examining the consumer surplus figures, it is well to keep in mind that these benefit estimates are affected by the probability that a boater will go to a particular site, the number of trips taken, given that the boater goes to the site, as well as the size of the own-price coefficient. The figures in columns 3 and 6 are estimates per boater of how the value of access to a site changes with changes in the environmental variable. These surpluses are not additive across sites. That is, if we want to consider the effects of a ten-percent decrease in TNP throughout the Chesapeake Bay, we cannot add surplus changes across sites. Each estimate of surplus per boater by site assumes that the water quality at other sites remains fixed. The bias which would be created by simple aggregation across sites depends on price and quality elasticities and is of unknown size.

What do all these calculation say about the value of reductions in the nitrogen/phosphorus variable? We can estimate the aggregate benefits of changes in TNP from Tables 5.12, 5.13, and 5.14 by expanding these estimates from the sample to the population of boat owners who trailer their boats. Consider St. Mary's County. We have two estimates of the increase in ● Urplus associated with a 10 percent decrease in TNP. These suggest a range of between $1 and $5 per boater per season. If there are about 80,000 boaters who trailer in Maryland (about the number estimated by Harmon and Associates for 1983), we would estimate a change in total surplus in the range of $575,000 to $1,400,000 annually for a 20 percent reduction in TNP at the sites that Anne Arundel County comprises. This calculation assumes that the original sample from which the benefit estimate. were derived is representative of the boater population as a whole.

The results in these tables eeem at least plausible. For example, surpluses appear highest for western shore waters, those moat easily accessed by the concentration of population in the state. The surplus figures for any given site are not especially large, but this is to be expected since when boaters have the ability to substitute relatively cheaply among sites, very high surpluses at any one site would violate some prior expectations on the size of benefits. While the magnitudes of returna from changes in TNP are not extremely large on a per-boater basis, in the aggregate they are quite substantial

Table 5.12
Per Boater Annual Benefits from a 10% Decrease in Pollutant in each Geographical Area

County with Water Quality Change	Calculation Method A			Calculation Method B		
	Consumer Surplus Before Change	Consumer Surplus After Change	Benefits	Consumer Surplus Before Change	Consumer Surplus After Change	Benefits
Anne Arundel	$30.01	$33.30	$3.29	$119.05	$127.46	$8.41
Baltimore	15.07	17.38	2.32	49.83	54.95	5.12
Calvert	17.50	18.60	1.11	108.57	111.38	2.81
Cecil	4.80	5.43	.63	18.55	19.51	.96
Charles	38.79	46.05	7.26	38.34	43.40	5.05
Dorcester	1.61	1.78	.17	75.72	78.15	2.43
Harford	3.45	3.89	.45	47.24	49.63	2.38
Kent	24.08	27.09	3.00	73.71	76.86	3.15
Queen Anne's	26.17	28.99	2.81	51.74	53.98	2.24
St. Mary's	14.80	16.03	1.23	139.22	143.71	4.49
Somerset	7.17	7.60	.44	99.18	101.95	2.77
Wicomico	7.87	8.60	.73	32.82	34.53	1.71

Table 5.13
Per Boater Annual Benefits from a 20% Decrease in Pollutant in each Geographical Area

County with Water Quality Change	Calculation Method A			Calculation Method B		
	Consumer Surplus Before Change	Consumer Surplus After Change	Benefits	Consumer Surplus Before Change	Consumer Surplus After Change	Benefits
Anne Arundel	$30.01	$37.17	$7.16	$119.05	$137.05	$18.01
Baltimore	15.07	20.33	5.26	49.83	61.20	11.37
Calvert	17.50	19.79	2.30	108.57	114.35	5.78
Cecil	4.80	6.17	1.38	18.55	20.60	2.06
Charles	38.79	55.54	16.75	38.34	50.13	11.79
Dorcester	1.61	1.98	.37	75.72	80.74	5.03
Harford	3.45	4.41	.97	47.24	52.27	5.03
Kent	24.08	30.51	6.42	73.71	80.38	6.67
Queen Anne's	26.17	32.18	6.00	51.74	56.51	4.76
St. Mary's	14.80	17.40	2.61	139.22	148.54	9.32
Somerset	7.17	8.08	.91	99.18	104.88	5.70
Wicomico	7.87	9.46	1.59	32.82	36.44	3.62

Table 5.14
Per Boater Annual Losses from a 20% Increase in Pollutant
in each Geographical Area

County with Water Quality Change	Calculation Method A			Calculation Method B		
	Consumer Surplus Before Change	Consumer Surplus After Change	Losses	Consumer Surplus Before Change	Consumer Surplus After Change	Losses
Anne Arundel	$30.01	$24.76	$5.24	$119.05	$105.07	$13.98
Baltimore	15.07	11.68	3.38	49.83	41.96	7.87
Calvert	17.50	15.51	1.99	108.57	103.98	5.19
Cecil	4.80	3.80	1.00	18.55	16.93	1.62
Charles	38.79	28.78	10.01	38.34	31.51	6.83
Dorcester	1.61	1.33	.28	75.72	71.30	4.42
Harford	3.45	2.74	.71	47.24	43.12	4.13
Kent	24.08	19.12	4.96	73.71	68.34	5.37
Queen Anne’s	26.17	21.48	4.70	51.74	47.93	3.81
St. Mary’s	14.80	12.70	2.09	139.22	131.10	8.12
Somerset	7.17	6.40	.77	99.18	94.08	5.10
Wicomico	7.87	6.68	1.19	32.82	29.88	2.94