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F I N A L   R E P O R T

THE VALUE OF RECREATIONAL FISHING ON THE ALBEMARLE AND PAMLICO ESTUARIES

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ABSTRACT

The objective of this project is to develop economic models of how individuals use the Albemarle-Pamlico Sounds for recreational fishing. In the process, we sought to describe demands for marine fishing. These models would be used to evaluate one aspect of the benefits people would realize from improvements in the quality of these resources. Management policies directed to reducing the effluent loading entering the sounds could then be evaluated.

Research supported by this project has proceeded in four stages. First, the principal investigators prepared a review of the economic models currently available to describe the demand for comparable types of marine recreational fishing and the values of improvements in its quality (see Smith and Palmquist, 1988). Based on this review, it was concluded that the available research was quite limited, specific to the areas studied, and not easily transferred to the situation in North Carolina.

The second step in the research involved developing a data base that included a complete description of a sample of users' recreational fishing decisions in the area, their potential opportunities for fishing, and measures of the quality of the resources involved. This work involved enhancing an intercept survey collected for the area by the North Carolina Sea Grant Program during 1981 and 1982 to include measures of site quality and the distances to all other marine recreation sites in the area.

The third aspect of the research required development of a model of recreational decisions relevant to the specific circumstances in the region. Based on the earlier review, a model was structured and described at a public meeting involving input of Sea Grant personnel, representatives of recreational fishing groups, staff from the state, and other economists and social scientists knowledgeable about the area. This was completed in January 1988.

The last component of the work has involved estimating and evaluating demand models based on the enhanced data base. This work has found that the recreational fishing for the area involves primarily residents of coastal or nearby counties. Demand models have been successfully estimated for two broad usage areas--the Pamlico and Outer Banks regions. These models include the average catch rates for all boat fishermen using specific entry points as a measure of the quality of area of the estuary for fishing. Based on these estimates, our preliminary findings suggest that a 25 percent increase in the catch rate would increase the value to a fisherman of a typical fishing trip to each area by between $10 and $71 in 1981 dollars.

Moreover, related work with these same data sponsored by the North Carolina Sea Grant has been influenced by our early findings. This subsequent research has used several alternative frameworks and indicates that the benefit estimates derived for improvements in fishing quality may be quite sensitive to the modeling frameworks and assumptions used to develop them. The primary distinction between these new models and the work undertaken in this project is an alteration in the assumed perspective from which people make their decisions. The new models assume recreationists consider each trip individually and have a local orientation in their fishing decisions. The work remains preliminary but offers the prospect of gauging how specific improvements at individual locations along the coast might influence the patterns of use of these areas and the benefits derived by the recreationists involved.

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EXECUTIVE SUMMARY

This research was developed to estimate the benefits to recreational fishermen from improved fishing quality that might arise from managing the Albemarle-Pamlico Estuary to meet the goals of the National Estuary Program. The Albemarle-Pamlico Estuarine Study is part of the National Estuary Program authorized under the Water Quality Act of 1987. This legislation identifies the goals of the National Estuary Program to be:

> "...the attainment or maintenance of water quality in an estuary which assures protection of public water supplies and the protection and propagation of a balanced, indigenous population of shellfish, fish, wildlife, and allow recreation activities, in and on the water ..."

Among the seven categories identified as objectives of the National Estuary Programs, two are especially relevant to research described in this report:

- to develop the relationship between the in-place loads and point and nonpoint loadings of pollutants in the estuarine zone and the potential uses of the zone, water quality, and natural resources;

  and

- to develop a comprehensive conservation and management plan that recommends priority corrective actions and compliance schedules addressing point and nonpoint sources of pollution to restore and maintain the chemical, physical, and biological integrity of the estuary, including restoration and maintenance of water quality, a balanced indigenous population of shellfish, fish and wildlife, and recreational activities in the estuary, and assure that the designated uses of the estuary are protected. (emphasis added)

A management plan to preserve and enhance the quality of the sounds should consider the value of the potential enhancements that can result from policies to restrict the introduction of effluents into the sounds. Recreational fishing is one of the most important uses of the Albemarle and Pamlico Sounds, yet fishing activity can be severely affected by effluents entering the sounds from upstream and adjoining activities. The values generated by recreational fishing are more difficult to determine than the values provided by activities, such as commercial fishing, where markets provide price information. Nonetheless, the value of recreational fishing and related activities should have a significant role to play in the decision-making process governing estuarine management.

Connecting specific policies in a management plan to measures of the benefits they ultimately yield is a complex process. It cannot be treated in isolation from economic models of how people respond to changes in the physical and aesthetic features of an estuary and the resources it supports.

The attached figure provides an overview of the process. Economic responses to quality changes are the last component in the sequence of changes and are identified at the bottom of the figure under the heading behavioral effects. The full sequence begins with the management plan and its implications for firms, households, farmers, etc. that contribute to effluent loadings (identified at the top of the figure). Their responses to the limitations on their activities that would be part of a plan determine how effluent loadings will change. These changes have implications for resources (i.e., fish populations) supported by the estuary because these loadings affect water quality. Water quality affects the extractive (e.g., commercial and recreational fishing, etc.) and non-extractive uses (e.g., boating, fishing, etc.) of the area. It is these uses that contribute to the economic value of the estuary as well as determine the incremental values generated by management plans.

This research contributes one component to this overall scheme.

The research had four goals:

- review and evaluate past models of the demand for marine recreational fishing;

- evaluate the feasibility of using existing work in a conservation and management plan for the Albemarle-Pamlico Sounds;
- develop conceptual and corresponding preliminary empirical models of the demand for marine recreational fishing;
- estimate the benefits of improving fishing quality in the estuary and compare them with other estimates for similar resources.

Because our review of the existing recreation demand literature indicated that the available studies would not meet the need for analyzing sport-fishing in the Albemarle-Pamlico Sounds, we developed our own demand estimates. Using an augmented version of a survey of recreational fishermen conducted in 1981 and 1982 by the North Carolina Sea Grant Program, we estimated a new version of the travel cost demand model for composite recreation sites identifying the major destinations within the estuary. Two of the three composite sites defined using coastal launch points - the Pamlico and the Outer Banks areas - were found to have stable, economically plausible demand estimates that included a measure of fishing quality as a positive influence to an individual's demand for fishing in these areas.

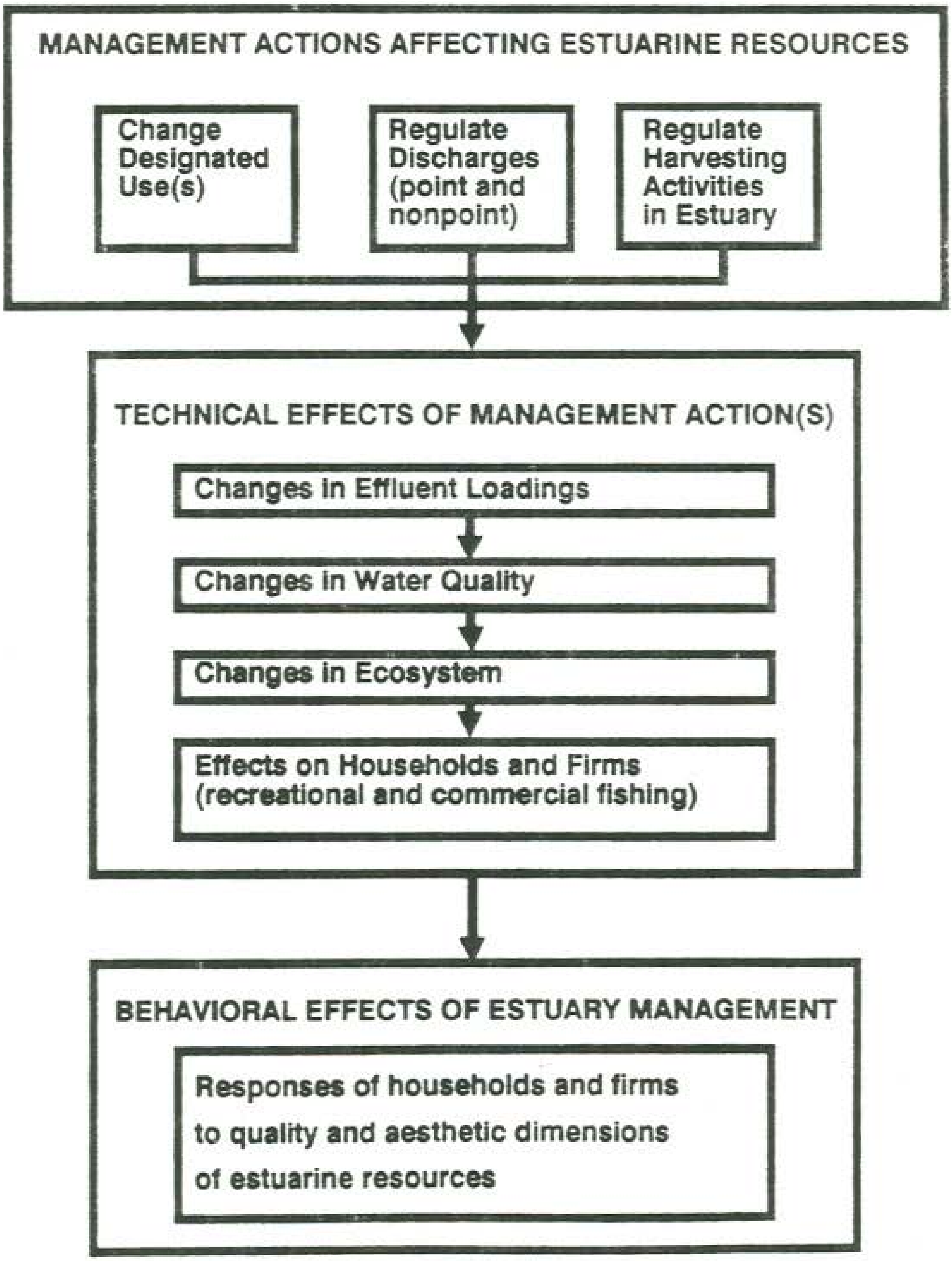
The results for the Outer Banks proved to be quite robust with respect to the specification of the estimating equation. While most visitors to the other two areas came from within 200 miles of the site, the Outer Banks sites drew visitors from much greater distances, as well as from the local area. Because of the prospects for differences in the demand functions or implicit assumptions underlying the travel cost model, two separate demand functions were considered for the Outer Banks demand models - one for visitors within 200 miles and a second using the full sample. In both cases, the coefficients of the variables had the expected signs and most were statistically significant. The coefficients of travel cost, our implicit price measure, were negative and significant as expected. The catch rate-travel cost interaction terms were positive and significant as expected. For the Pamlico area the results were similar, generally having the expected sign and significance.

The coefficient estimates were used to estimate the price elasticity of demand for recreation in the Outer Banks and Pamlico areas. The price elasticity of demand measure the responsiveness of the quantity demanded to changes in the price or cost of using the site. It is measured as the percentage change in the number of visits to the site if price increases by one percent. In both areas, the elasticity was between zero and minus one, implying that the demand is inelastic or somewhat less responsive to price. More specifically, the estimates indicate that a one percent rise in price would result in a .53 to .66 percent reduction in the number of visits an individual would take, depending on whether the full sample or the less-than-200-miles sample estimate was used. For the Pamlico area, a similar one percent rise in costs would result in a .90 percent reduction in visits. Both sets of estimates fall within the range of estimates for this type of recreation.

We also estimated the consumer surplus per trip for the typical recreationist and the change in this surplus with improvements in quality as measured by the average catch rate. The consumer surplus describes the difference between what the individual would be willing to pay for the trip and what he actually had to pay (in travel and opportunity costs). The estimates for the per-trip value were large, but do fall within the range from past studies, especially when the restricted version of the Outer Banks model was used. For Pamlico, the per-trip surplus was about $100. For the restricted Outer Banks it was approximately $140. A catch rate improvement of 25 percent would be worth about $71 to a fisherman on the Outer Banks using the estimate for the full sample. For those from within 200 miles who used the Outer Banks, the consumer surplus was about $24, and for the Pamlico it was just under $10. On the other hand, if there was a 25 percent decrease in phosphorus loading on the sounds, the increase in consumer surplus would be about $60 and $20 for the Outer Banks full sample and within-200 miles sample respectively. On the Pamlico, a similar reduction would be worth only $2.46.

The research to date has clearly established the feasibility of quantifying the benefits from management programs for one of the important recreational activities for the estuary. What remains to be done involves extending this type of analysis to include all of the activities enhanced through improvements in the estuary.

EFFECTS OF MANAGEMENT OF ESTUARINE RESOURCES



Chapter 1

Introduction and Overview

1.1 Goals

The Albemarle-Pamlico Estuarine Study is part of the National Estuary Program authorized under the Water Quality Act of 1987. This legislation identifies the goals of the National Estuary Program to be:

> "...the attainment or maintenance of water quality in an estuary which assures protection of public water supplies and the protection and propagation of a balanced, indigenous population of shellfish, fish, wildlife, and allow recreation activities, in and on the water. ."

To meet this broad objective, Section 317 of the Act emphasizes the need for planning. Indeed, the cooperative agreements initiated between EPA and states are intended to lead to the development of a comprehensive conservation and management plan for each estuary because "long-term planning and management will contribute to the continued productivity of these areas, and will maximize their utility to the Nation."

Specific purposes of the National Estuary Programs are identified in Section 320 of the Act. Among the seven categories identified, two are especially relevant to research described in this report:

- to develop the relationship between the in-place loads and point and nonpoint loadings of pollutants in the estuarine zone and the potential uses of the zone, water quality, and natural resources;

  and

- to develop a comprehensive conservation and management plan that recommends priority corrective actions and compliance schedules addressing point and nonpoint sources of pollution to restore and maintain the chemical, physical, and biological integrity of the estuary, including restoration and maintenance of water quality, a balanced indigenous population of shellfish, fish and wildlife, and recreational activities in the estuary, and assure that the designated uses of the estuary are protected. (emphasis added)

In order to achieve these objectives, substantial data collection and research on the natural science features of the estuary are needed. It is essential to understand the complex physical and biological relationships linking inflows of effluent loadings to the effects on the estuary as a resource and the services it provides.

To establish priorities and a plan to meet them, we must first acknowledge that any action to reduce effluent loadings will have costs and yield certain changes in activities that affect the services and quality of the estuary. Because these costs and outputs will be different across the alternatives that will comprise a conservation and management plan, it is important to assess the magnitude of the benefits that will be achieved by the different policy alternatives. Indeed, the Albemarle-Pamlico Estuarine Study Work Plan states at the outset that: "Finding realistic, workable means to mediate conflicts between human uses clearly depends upon understanding interactions between human uses and natural systems." (Emphasis added.) The Policy Committee for the Study has similarly resolved that:

> The goal of the Albemarle-Pamlico Project will be to provide the scientific knowledge and public awareness needed to make rational management decisions so that the Albemarle-Pamlico estuarine system can continue to supply citizens with natural resources, recreational opportunities, and aesthetic enjoyment. (emphasis added)

1.2 Highlights of Findings

The purpose of this research was to estimate the benefits provided to recreational fishermen by managing the Albemarle-Pamlico estuary (APES) in order to enhance fishing quality. More specifically, we proposed four goals, to:

- review and evaluate past models of the demand for marine recreational fishing;
- evaluate the feasibility of using existing work in a conservation and management plan for the Albemarle-Pamlico Sounds;
- develop conceptual and corresponding preliminary empirical models of the demand for marine recreational fishing;
- estimate the benefits of improving fishing quality in the estuary and compare them with other estimates for similar resources.

Because our review of the existing recreation demand literature indicated that the available studies would not meet the need for analyzing sport-fishing in the Albemarle-Pamlico Sounds, we developed our own demand estimates. Using an augmented version of a survey of recreational fishermen conducted in 1981 and 1982 by the North Carolina Sea Grant Program, we estimated a new version of the travel cost demand model for composite recreation sites identifying the major destinations within the estuary. Two of the three sites - the Pamlico and the Outer Banks areas - were found to have stable, economically plausible demand estimates that include a measure of fishing quality as a positive influence to an individual's demand for fishing in these areas.

To illustrate the use of these models, we estimated the increase in value that an individual would place on a typical fishing trip if the availability of fish improved by 25 percent. Because this quality measure for fishing varies within each area, the benefits an individual would realize depends on where the improvements occur. Figure 1.1 displays a subset of our estimates of the per-trip benefit a typical fisherman would realize on a map of the area. Based on our final demand models, these estimates range from $2.00 to $38.00 for most of the launch areas in the Outer Banks destination and $2.00 to $14.00 for the Pamlico entry points. These are measured in 1981 dollars. These differences

- review and evaluate past models of the demand for marine recreational fishing;
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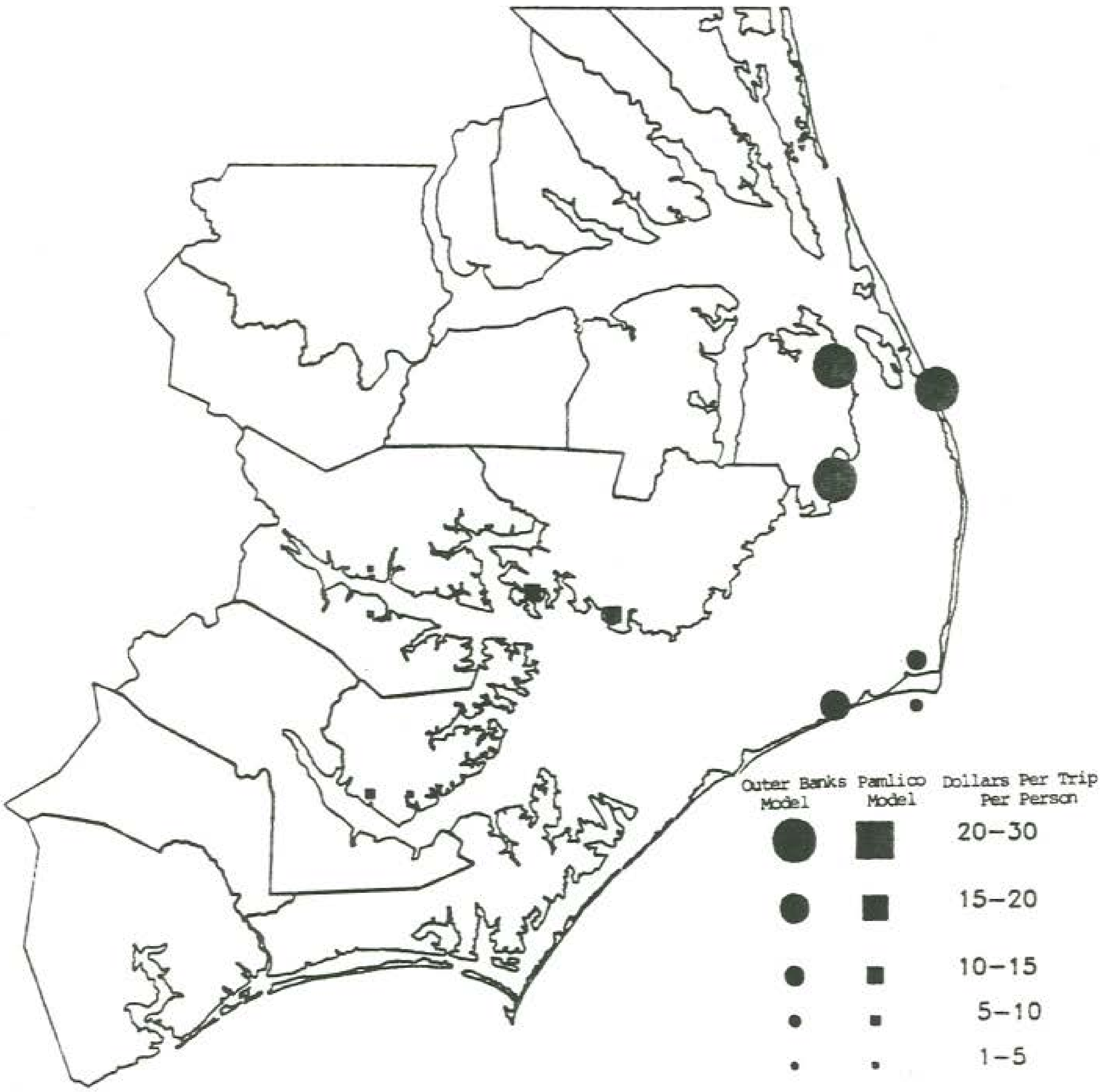
FIGURE 1.1

Geographic Distribution of Values of a
Twenty-five Percent Improvement in Catch Rates



are primarily the result of differences in the base level of fishing quality from which these improvements take place. Nonetheless, by separating recreationists by the three destination areas, we do reflect some of the diversity in the other physical characteristics, including the types of fish at the various locations within the estuary.

Overall, our research findings exceeded the original goals. They have demonstrated the feasibility of developing models that are responsive to the needs of a comprehensive conservation and management plan, and have developed a set of preliminary models for valuing changes in an important segment of the activities supported by the Albemarle-Pamlico estuary - recreational fishing. Finally, our results have been developed within the context of a larger program of research that should permit us to evaluate how sensitive these estimates are to the modeling assumptions implicit in their development, and thereby to ultimately propose a "best" estimating framework for measuring the aggregate benefits from alternative management policies.

1.3 Overview of the Report

As with most other types of recreation, marine recreational fishing is an activity that takes place outside conventional economic markets. One of the most important implications of this feature of most recreational activities is that the information a market provides on peoples' values of the goods or services exchanged is not available. This implies that analysts must determine the willingness to pay of the recreationists for the activity indirectly. Recreationists do face various costs such as travel and time costs to reach the recreation site, as well as launch fees or rental fees for boats. There are a number of economic techniques that utilize information on such costs to determine the value recreationists implicitly place on the site they select for specific recreational activities.

The various methods that have been used are reviewed in Chapter 2. While there are many differences in the details of the applications, the techniques can be roughly separated into three groups: travel cost models, hedonic travel cost models, and random utility travel cost models. Travel cost models estimate the demand for a site using travel costs as a measure of the implicit price of the site. Hedonic travel cost studies assume that recreationists have demands for the various features of recreation sites that contribute to their quality and attempt to determine the underlying demands for each of these characteristics. Finally, random utility models use a probabilistic framework to explain a recreationist's choice of a particular site from among a number of possible sites. When the interest is in measuring the value of site quality rather than the site itself, each of these methods is generally more complex.

While there have been numerous studies of the value of other types of recreational activities, only a limited number previously have attempted to measure the economic value of marine recreational fishing. Chapter 3 reviews the studies that have been done for the types of marine recreational fishing found on the Albemarle and Pamlico Sounds. Most of this work is quite recent and has utilized one of three modeling frameworks: the travel cost method, the random utility model, or the contingent valuation or survey framework. Chapter 3 describes why it would be difficult or impossible to transfer the results from other locations to the North Carolina sounds. Moreover, it also discusses other limitations with these other studies. One of the most important of these shortcomings arises because few have successfully isolated the effects of site quality on recreationists' demands for fishing.

Our study used data from a number of sources. The most important of these is an intercept survey of boat and bank fishermen on the Albemarle and Pamlico Sounds that was conducted by North Carolina Sea Grant during the 1981 and 1982 seasons. This survey collected information on the respondent, the party, the equipment, and the catch, as well as the number of other trips made in the previous year. The survey provided an unusual opportunity because the amount and variety of information collected far exceeds that of other surveys available for this area. Even so, the survey had to be supplemented with a number of other types of data. The distances traveled from each county of origin to all of the identified entry points into the sounds were measured from highway maps. Estimates of each respondent's wage rate in 1981 were developed based on a hedonic wage model relating hourly wage rates to job and individual characteristics. Using this information from the survey responses, a predicted wage was assigned and then used in valuing the travel-time costs for each individual. Information on motor vehicle operating costs were also used in deriving travel costs. The average catch rates were calculated for each launching point identified in the survey. Finally, pollution discharge levels for biochemical oxygen demand, suspended solids, nitrogen, phosphorous, and waste-water were obtained from NOAA. Point source, nonpoint sources, and upstream loadings were available. A detailed concordance linking the launch points and adjoining areas to the locations relevant for each set of effluent loadings was prepared so the two data files could be merged.

Our analysis develops a new version of the travel cost recreation demand model. Because of the significant differences in the physical and biological nature of the Albemarle and Pamlico Sounds, each is treated as a distinct set of destinations. Further, differences in the character of the Outer Banks sites also warranted separate treatment. Thus, our demand modeling identifies three major destinations: Outer Banks, Pamlico, and Albemarle within these areas. As a result of differences in these entry points and their characteristics, fishing quality differs across individuals using the same overall destination or composite site. Our conceptual analysis of the implications of the treatment of quality in recreation demand models demonstrates that there are at least three theoretical models that can be used to generate our estimating model. In each case, site quality (as measured by the average catch rate for the site) interacts with travel costs to affect the number of fishing trips made. In addition, the travel costs to the substitute areas as well as various socioeconomic characteristics of the individuals involved play a significant role in the choices made. Both ordinary least squares and maximum likelihood estimators were used. The latter allows for the truncation in the measure of use arising from the use of a site intercept survey.

The results for the Outer Banks proved to be quite robust with respect to the specification of the estimating equation. While most visitors to the other two areas came from within 200 miles of the site, the Outer Banks sites drew visitors from much greater distances, as well as from the local area. Because of the prospects for differences in the demand functions or implicit assumptions underlying the travel cost model, two separate demand functions were considered for the Outer Banks demand models - one for visitors within 200 miles and a second using the full sample. In both cases, the coefficients of the variables had the expected signs and most were statistically significant. The coefficients of travel cost, our implicit price measure, were negative and significant as expected. The catch rate-travel cost interaction terms were positive and significant as expected. For the Pamlico area the results were similar, generally having the expected sign and significance. The only area where the results were not successful was the Albemarle destination where the models were unstable and largely noninformative.

The coefficient estimates were used to estimate the price elasticity of demand for recreation in the Outer Banks and Pamlico areas. The price elasticity of demand measures the responsiveness of the quantity demanded to changes in the implicit price or cost of using the site. It is measured as the percentage change in the number of visits to the site if price (travel cost) increases by one percent. In both areas, the elasticity was between zero and minus one, implying that the demand is inelastic or somewhat less responsive to price. More specifically, the estimates indicate that a one percent rise in price would result in a .53 to .66 percent reduction in the number of visits an individual would take, depending on whether the full sample or the less-than-200-miles sample estimate was used. For the Pamlico area, a similar one percent rise in travel costs would result in a .90 percent reduction in visits. Both sets of estimates fall within the range of estimates for this type of recreation.

We also estimated the consumer surplus per trip for the typical recreationist and the change in this surplus with improvements in quality. The consumer surplus describes the difference between what the individual would be willing to pay for the trip and what he actually had to pay (in travel and opportunity costs). The estimates for the per-trip value were large, but do fall within the range from past studies, especially when the restricted version of the Outer Banks model was used. For Pamlico, the per-trip surplus was about \$100. For the restricted Outer Banks model, it was approximately \$140.

As we summarized at the outset, we also used the models to estimate the values of improvements in the qualities of the Sounds. If catch rate could be increased by 25 percent by reducing environmental degradation, this would be worth about $71 to a fisherman on the Outer Banks using the estimate for the full sample which included people who traveled longer distances to use the resource. For those from within 200 miles who used the Outer Banks, the consumer surplus was about $24, and for the Pamlico it was just under $10. On the other hand, if there was a 25 percent decrease in phosphorus loading on the sounds, the increase in consumer surplus would be about $60 and $20 for the Outer Banks full sample and within-200 miles sample respectively. On the Pamlico, a similar reduction would be worth only $2.46.

Overall the findings are encouraging. They demonstrate the feasibility of developing the information necessary to consider the tradeoffs inherent in a comprehensive management plan. By offering the prospect of a flexible, site-specific method for estimating an important component of the benefits the public realizes from improvements in estuarine quality, we have one central element in the support materials needed to prioritize the actions considered in the policy-making process.

Chapter 2

The Theory and Implementation of Travel Cost Recreation Demand Methods

2.1 Introduction

This chapter describes the travel cost model.[1] It begins with the assumption that the reader is largely unaware of this literature and seeks to accomplish three tasks: (1) to describe the theoretical underpinnings for travel cost demand models; (2) to outline how that theory is adapted to meet the special requirements imposed by the different types of data describing how recreational resources are used; and (3) to highlight the implications of this past research for the models we have developed to describe marine recreational fishing in the Albemarle-Pamlico Estuary.

Because our view of economic modeling will affect how we describe the microeconomic rationale for Hotelling's suggestion and its implementation, a brief description of this perspective seems warranted. Applications of microeconomic models of behavior should acknowledge that the analysts involved will never know the true function motivating behavioral decisions or the constraints defining the feasible choices. The people involved in making these choices will <u>always</u> know more about their goals, circumstances, perceptions, and constraints than analysts can hope to learn through observation or interviews. Equally important, analysts will always incompletely observe the variables to be used in estimating models derived from our characterization of decision processes.

A model is then a strategy for organizing what we hypothesize motivates and constrains a particular class of decisions. Together with what has been observed (or in the case of contingent valuation or behavior studies, what has been asked), models can be used to describe or test economic relationships. This has at least two implications for the process of evaluating applied microeconomic models. First, the stochastic assumptions used to characterize an "ideal" error structure in estimating demand models should be regarded as a set of standards for the adequacy of the model and not as separate influences to the observable measures of demand.

Second, and perhaps most relevant to current developments in recreation demand modeling, deriving the demand function as a direct analytical realization of an optimizing model for an individual's recreational choices is not necessarily a superior description of those choices. It is one strategy. As with any alternative strategy, its relative merits remain to be established.

Section 2.2 describes the theoretical rationale for the travel cost method using Becker's [1965] household production framework to organize the discussion. In Section 2.3, the methods used to implement the model are described, including the type of data and form of the model - conventional demand, random utility, and hedonic travel cost. The last section summarizes the chapter.

2.2 Modeling Recreation Decisions

The most important reason for using a household production framework to describe an individual's recreation decisions arises from the need to consistently represent the connection between the demands for recreational activities (such as skiing, boating, or fishing) and the demands for the recreation sites that support them. For the most part, the framework has largely served to help analysts in explaining the model and the implications of limitations arising from its empirical implementation for what could be said about behavior.

The basic model maintains that an individual's utility is derived from consuming services that are produced by that person (or his household) combining time, market-purchased commodities, and environmental resources. Because it has been largely used as a pedagogic framework in recreation models, the issue of measuring service flows has not been considered in any detail. We will argue below that this may change.

We can illustrate most of the key issues with the model with a simplified analytical structure. First, the utility function is specified in terms of the household-produced service flows, designated here with S's in equation (1). $\bar{S}$ designates a vector of non-recreation service flows and S_r designates the recreation service flow.

$$U = U(\bar{S}, S_r) \qquad (1)$$

Any one of these service flows, say S_K, is produced by combining market-purchased inputs, environmental resources, and household time. To keep our discussion simple, we assume there is only one recreation service, S_r. For recreational activities, the environmental resources are the services provided by recreation sites. The household production function for S_r distinguishes a market-purchased good, X_r (again a simplification); time at a recreation site per visit, t_ℓ^i (where i designates the site and ℓ the specific trip to site i); and visits to a site, V_j, as contributing inputs in equation (2).

$$S_r = f_r\ (X_r;\ V_1,\ldots,V_D;\ t_1^1,\ldots t_{V_1}^1,\ t_1^2,\ldots,t_{V_2}^2,\ t_1^D,\ldots t_{V_D}^D) \qquad (2)$$

These models generally specify the production processes for nonrecreation services in simple terms, as they are usually a small part of the analysis. The balance of the model can be given by the budget and time constraints given in (3a) and (3b).

$$wt_w + I = P_r X_r + \sum_{j=1}^{C} P_j X_j \qquad (3a)$$

$$t = t_w + \sum_{k=1}^{D} V_K t_K + \sum_{k=1}^{D} \sum_{\ell=1}^{V_k} t_\ell + \sum_{j=1}^{K} t_j \qquad (3b)$$

Equation (4) combines them into one form for the budget constraint. A simple substitution of (3b) into (3a) for t_w would imply that all time was implicitly "priced" at the wage rate. So our development of (4) recognizes a link between full income, y, and the allocation of resources between market commodities, trip, and time, but also for varying opportunity costs of time determined <u>outside</u> the model. Monetary income is wage (wt_w) plus nonwage (I) income. It is spent on the one good (or composite of goods) used in recreation (X_r) and those not used in producing recreation services (X_j, j =1 to C), with P_r and P_j (j = 1 to C) the respective prices. A trip to a recreation site involves the vehicle-related costs of travel (c dollars per mile traveled, dk) and the opportunity cost of travel time, with this type of time designated as t_k. We assume here that this cost is fixed at r dollars per unit of time. A fixed entry fee could be included but is not at this stage. Notice that this formulation assumes that on-site time per trip and the time spent in producing nonrecreation services have the same opportunity cost, which is the wage rate. We will return to this assumption and relax it later.

Equation (4) indicates that monetary income, $wt_w + I$, and time are allocated to market goods and travel expenditures, and time involvement in other activities, but that these decisions implicitly allocate full income, $y = \bar{w}_t + I$, where $\bar{t}$ is the total time that would be available for work. The right side of the equation is different from what Becker's [1965] early description would be, because we have allowed the opportunity costs of some types of time to differ from the wage rate. $P_r X_r + \sum_{j=1}^{C} P_j X_j$ represent monetary expenditures for goods and services. $\sum_{k=1}^{D} cd_k V_k$ is also a monetary expenditure, while $\sum_{k=1}^{D} \left[rt_k V_k + w \sum_{\ell-1}^{V_k} t_\ell^k \right] + w \sum_{j=1} t_j$ are implicit monetary allocations because an individual forgoes $w(\bar{t} - t_w)$ to use his time in this way.

$$y = w\bar{t} + I = P_r X_r + \sum_{j=1}^{C} P_j X_j + \sum_{k=1}^{D} \left[(cd_k + rt_k)\, V_k + w \sum_{\ell=1}^{V_k} t_\ell^k \right] + w \sum_{j=1}^{K} t_j \qquad (4)$$

Equations (2) and (4) provide the central elements in the household production framework's explanation of alternative travel cost demand models. Activities in this model are the services that are produced by households, while the services of a recreation site serve as an input to those production activities. Thus, the travel cost demand model as originally envisioned by Hotelling [1947] is a demand for the services of a recreation site. It is a derived demand arising because individuals engage in recreation at the site. But this is not the end of the theory underlying the models. Much more of the travel cost model's story can be developed by examining the elements in a typical production function, as well as the specification for the other constraints.

B. The Role of Time Horizon

Consider first the arguments of the recreational services production function given in (2). The first implication of this specification is that the time horizon assumed for this individual's decision making must be long enough that a specification of multiple visits to various sites would be possible. Thus the model would apply to descriptions of the seasonal demand for a recreation site. It treats the individual's decisions as if they were planned at the outset of the season and coordinated among the various recreation sites that are selected. In most applications of the model, analysts attempt to hold the time on site per visit constant. By focusing on weekend trips or analyzing demand for each trip length separately, this reduces the number of time arguments that are specified to enter the household production function. Only one on-site time input is then required for each site's visits.

By distinguishing the count of visits from the time on-site, the production process acknowledges the possibility that a five-day visit is not the same as five one-day visits in their respective contributions to the recreational activities involved. A judgment about whether this specification is reasonable depends on the nature of the activities and the time horizon for decision making. For example, if one were to consider the implications of each type of assumption for the case of wilderness hikes, then a one-week trek into the Spanish Peaks area or the Adirondacks is not the same as five one-day trips. The areas one can gain access to, the mix of activities undertaken on site, and a variety of other factors are clearly influenced by the ability to take longer trips.

This distinction has direct relevance to current recreation demand models. For example, Wilman's [1987] simple repackaging model assumes that this distinction is not important and specifies the measure of site usage as days-on-site. In terms of our production function, her model would replace the arguments describing site usage in the production function given in (2) by the sum of all days on site over trips (Σt^i_ℓ, with i = site, ℓ = trip, and t^i_ℓ, the time on site per trip).

The characterization of the time horizon for decision making also plays an important role in describing the relationship between conventional travel cost demand models and random utility models (RUM) estimated from travel cost data. It also offers a way to motivate models that assume only one of the available consumption items is selected, versus those that allow for a subset (but not all available goods) to have nonzero consumption levels. This conclusion follows because we can generally assume that as the time horizon is longer more decisions to use recreation sites can be treated as taking place "instantaneously," (when in fact they actually arise at time points <u>within</u> that horizon). It is possible to observe more than one visit to a site as well as multiple visits to several different sites. A static utility maximizing model will treat them as if they took place "instantaneously." With time horizons shorter than a week - a weekend or even a single day - then we expect that the decisions would be treated as implying corner solutions. A person selects <u>one</u> of the possible recreation sites for his visit and is then precluded from using the available alternatives at that same time. Correspondingly, the decisions cannot be assumed to arise as a set of small increments motivated by the first order conditions of a continuous model that assumes interior solutions.

This formulation also provides some insight into what substitution between recreation sites means in the context of a travel cost demand model. When the time horizon is specified so that the individual is assumed to make recreational decisions for a season, then the selection of one site for recreation does not preclude consumption of visits to another site. It is important to recognize that at this general level the model doesn't offer specific testable hypotheses on the role of substitutes. Only a few fairly general observations can be made. First, indexes of attractiveness of a site or broad summary indicators that arbitrarily characterize how other recreation sites influence an individual's (or group of individuals') use of a site are inconsistent with the household production framework.

Within an economic framework, we would expect that some measure of the prices for gaining access to substitute sites would enter any particular site's derived demand equation. To characterize available substitutes with an aggregate quantity index would not remove the requirement to use the implicit prices for gaining access to these sites. Rather, aggregation of sites' prices to a composite price index implies that the production function can be characterized as having a weakly separable subfunction in those site services. Therefore, a price index derived from that subfunction (or treated as an approximation to it) would be the relevant measure of these substitutes' effects.

The next issue that emerges from this simple description is the characterization of the relevant price for use of recreation site. In this most general form, increases in use can involve both additional trips to a site and more time on site. We can identify a variety of prices that would correspond to the unit costs of these two aspects of (or measures for) site use. For example, the cost of a trip would include the travel and time costs as represented by $cd_k + rt_k$ in equation (4). Round-trip mileage (d_k) times the unit cost per mile (c) together with the travel time required to reach a site (priced at the opportunity cost of time, r, in this formulation) would be the relevant price of the trip. A separate argument in the demand function involving the costs of using the site would be associated with the price of on-site time (designated as the wage rate, w, in this case). Of course, the relevant price changes as the specification of the individual's objective function and constraints change how the site is used. To see this point, a few simple modifications to the basic model are considered next.

C. Modifications in the Simple Model

This is not the most general characterization of either the production function or the budget constraint. Depending upon how each is represented, we introduce the issues that are present across the wide array of existing applications of the travel cost methodology (see Smith and Kaoru [1989a]).

Table 2.1 displays the key elements of some of these alternatives and highlights their implications for the first-order conditions for the two choice variables of interest. While the necessary conditions do change, the specific testable hypotheses are more limited. To illustrate this point, consider the first row of the table with the simplest type of model that must be used to motivate a travel cost framework (see McConnell [1985] for an example). It simply adapts the conventional model of choice to fit

TABLE 2.1

A Gallery of Behavioral Models Underlying Travel Cost Demand Functions

Name	Obj Function	Income/Time Constraints	Recreation Production	First Order Condition Visits[1]	First Order Condition for On-Site Time[1]
a. Simple	$U(V, X)$	$y - P_V - P_X X = 0$	None	$U_v - \lambda P_v = 0$	...
b. Model in (1), (2), (4)	eq (1)	eq (4)	eq (2)	$U_{S_r} \frac{\partial f_r}{\partial V_k} - \lambda(cd_k + rt_k) = 0$	$U_{S_r} \frac{\partial f_r}{\partial t_j^k} - \lambda w = 0$
c. Constant on-site time per trip	eq (1)	$y - P_r X_r - \Sigma P_j X_j$ $- w\Sigma t_\ell$ $- \Sigma (cd_k + rt_k + wt^k) V_k = 0$	$f_r(x_r, V_1, \ldots V_D, t^1, \ldots, t^D)$	$U_{S_r} \frac{\partial f_r}{\partial V_k} - \lambda(cd_k + rt_k + wt^k) = 0$	$U_{S_r} \frac{\partial f_r}{\partial t^k} - \lambda w V_k = 0$
d. Simple Repackaging Model	eq (1)	(c)	$f_n (X_n, \Sigma V_k t^k)$	$U_{S_r} \frac{\partial f_r t^k}{\partial V_k} - \lambda(cd_k + rt_k + wt^k) = 0$	$U_{S_r} \frac{\partial f_r}{\partial t^k} V_k - \lambda w V_k = 0$
e. Jointly Produced Activities	eq (1)	(c)	R types of S_r's with V_k's or t_k's contributing to them	$\sum_{t=r_1}^{r_R} U_{S_r} \frac{\partial f_r}{\partial V_k} - \lambda (cd_k + rt_k + wt^k) = 0$	$\sum_{r=r_1}^{r_R} U_{S_r} \frac{\partial f_r}{\partial t^k} - \lambda w V_k = 0$
f. Multiple Destination Trips (for sites 1 to L)	eq (1)	(c) same model as c, different FOC	(c)	$U_{S_r} \left[\sum_{k=1}^{L} \frac{\partial f_r}{\partial V_k} \right] - \lambda (cd_k + rt_k + wt^k) = 0$	Same as (b) but no choice by trip
g. Multiple Time Constraints	eq (1)	$y - P_n X_n - \Sigma P_j X_j$ $- \Sigma cd_k V_k = 0$ $\bar{t}_1 - t_w - \Sigma t_j = 0$ $\bar{t}_2 - \sum_k V_k (t_k + t^k) = 0$	(c)	$U_{S_r} \frac{\partial f_r}{\partial V_k} - \lambda \left[cd_k + \frac{\theta_2}{\theta_1} w (t_k + t^k) \right] = 0$	$U_{S_r} \frac{\partial f}{\partial t^k} - \lambda \frac{\theta_2}{\theta_1} w V_k = 0$

[1] Designates the Lagrangian multipliers for the budget constraint.

[2] The θ_1 and θ_2 designate the Lagrangian multipliers for the first and second time constraints respectively.

recreation decisions by altering the definitions used to describe the measures for the amounts of a site's services and individual demands, as well as in how these services are priced. As the quote in note 1 suggests, Hotelling's suggestion called for using the aggregate of trips taken to a site from each origin zone with each zone's vehicle-related travel costs. In the next section, the issues associated with implementing the model are developed, and the relationship between aggregate and micro-data will be discussed. For now what is important is that use is measured by homogenous trips and the price is the travel cost (round-trip) to get there.

In this case, visits are specified to enter the utility function directly. The price is treated as an exogenous parameter. As we compare this formulation to those in the other rows, the form of the estimated travel cost demand model has different arguments (i.e. the variables specified as exogenous to choice are different). The dependent variable used to measure use of the recreation site also changes in some cases. Nonetheless, few of these alterations would admit testable hypotheses with the data sets currently available for modeling recreation demand. Instead, they provide a menu of the issues that are generally addressed in attempting to adapt a general description of the choice process to conform to the actual information available about recreation decisions for implementing that model.

For example, to implement the model implied by (1), (2), and (4) would require separate information on the length of time spent during each trip to each site during the individual's planning horizon. Of course, estimation of the demand for any one site would not use all of this information under this specification because it assumed the opportunity cost of all time (regardless of when or where the trip would be taken) was equal to the wage rate. A further interesting implication of this specification for the constraint is that there is no distinction between the time spent on site in various trips. It is equally scarce, as far as the model is concerned. This conclusion follows from the characterization of the time available for recreation offered in the budget constraint. Of course we could change this. If we were to allow different prices for time spent on-site in different trips, then each of these prices would reflect the relative scarcities of each type of time. This formulation would offer the motivation for substitution among the different types of trips. Because trips would all cost the same in terms of vehicle-related costs, the mix of types of trip would depend on their relative contributions to recreational activity reflecting the different opportunity costs of time.

In contrast, the third row assumes all trips to a given site are of constant length. This reduces the number of arguments in the household production function. It also restricts the types of adjustments an individual can make in planning his recreation trips and makes the conventional definition of the unit costs of a trip, as well as the time on site, endogenous variables. This result follows because each is related to the optimal decisions of the other component of site usage.[2]

Wilman's [1988] simple repackaging model in the fourth row treats all uses of a site (visits versus time per visit) as equivalent. This model would depart from conventional practice, which routinely assumes that trips of constant length are a relevant measure of site usage. The same cannot be assumed with a composite unit of site usage because the trip imposes a fixed cost that can be spread across the days spent on site for that visit. Thus the price per unit of use will not be a constant.

The remaining three rows of Table 2.1 identify issues that have been raised as important to the implementation of the model. Consider the model described in the last row first. This formulation offers one approach for relaxing the assumption that the market wage is the relevant opportunity cost of travel time. It also provides a theoretical rationale for the Cesario-Knetsch argument that the opportunity cost of time can be treated as a fixed multiple of the wage. This analytical description illustrates why their approach should be considered an approximation. Yet it also indicates why we might expect problems in implementing this approach. The multiple will vary depending on the diversity of conditions facing individuals. Thus, this formulation provides some insight into why the McConnell-Strand [1981] adaptation of Cesario and Knetsch's approach for treating travel time has failed in some adaptations.[3]

By adapting the literature on labor supply, Bockstael, Strand and Hanemann [1988] propose a more constructive approach. They argue that because different individuals will face different constraints on their ability to adjust their working time, we should first determine the nature of an individual's time constraints and reflect the effects of flexibility in working time on the opportunity cost of time.

The fifth row raises a new question for travel cost demand models.[4] Because individuals may produce multiple activities in a single trip to a recreation site (e.g. boating, fishing, and swimming), it is not sufficient to focus on their implicit prices and ability to pay to adequately describe differences in the demands for a site across people. This specification would imply, at least in principle, that we should include information about what they do on site.

Some descriptions of the travel cost framework have distinguished the trip as one commodity and the visit as another.[5] In these cases, it is then argued that the Hotelling [1947] suggestion amounts to assuming weak complementarity between trips (viewed as the process of transporting oneself to the site) and visits. This distinction becomes more important for situations where the visit is not the exclusive purpose of the trip (for example, the case of a vacation in which a recreationist visits several national parks in the same vicinity). It may also be important when the trip involves other nonrecreation-related objectives. Both cases introduce the equivalent of a cost allocation issue. That is, the cost of the trip must be allocated among the objectives. Of course, even in these cases, it is possible to identify the cost allocation questions raised by this characterization without using the weak complementarity argument to describe the travel cost model. We need only reformulate the household production model. Row f of Table 2.1 illustrates how this would be done for the case of multiple destination models. Multiple-destination trips may pose especially important problems for unique recreation sites that attract visitors from a national market, each with quite distinctive vacation itineraries.[6]

In contrast to the joint production row, which treats a trip to a specific site as a type of public input contributing to several recreational activities simultaneously, the multiple destination model (Haspel and Johnson [1982]) raises questions with the price measure because it assumes that recreationists may well visit multiple sites or accomplish other objectives for some types of trips. Joint production on site (given in row e of the table) does not imply we would incorrectly measure the site's unit cost, only that we might miss explanations for the demand variations we observe across people.

D. Introducing Site Characteristics

An important source of refinement in the travel cost models, and perhaps the primary focus of most of the current work extending the methodology, involves attempts to model the reasons why the demands for recreation sites are different. This is described analytically in the household production model by the fact that visits and time on-site per visit enter as distinctive inputs for each site. In principle this allows the marginal products of each type of site's services to contribute differently to the production of constant quality recreation services. Of course, the only empirical realization of the differences would be the distinctions in the derived demands for each site. In this form, we do not know what gives rise to the differences.

To the extent we can identify and measure features of recreation sites that are important to the recreational activities "produced" at a site, then there are opportunities for enhancing the model and "explaining" some of the reasons the same individual may have a different demand function for two different recreation sites.

An equally important motivation for such an extension arises because some of the features may be subject to change through management policies. In developing the role of site characteristics in travel cost models, it is useful to distinguish two types of attributes: the physical characteristics of the recreation site, and the physical and aesthetic characteristics of the services a site provides. While the modeling issues associated with the role of each type of attribute in describing individuals' demands will be comparable, the issues associated with implementing models for measuring each type will be different. Equally important, any uses of the demand models to address management issues will be different for these two types of features.

Examples of physical measures of the characteristics of a recreation site would include: water quality; stock of game or fish; number of campsites and boat ramps, size, scenery, etc. These are specific physical attributes that contribute to what might be described as the quality of the site. Because quality will depend on how a site is used, most of the discussion in the applied literature has focused on these types of specific measures rather than some generalized index of quality. Examples of the second type of attributes would include congestion and litter. They are more related to the number of users in a site during a specific time.

Four important issues do arise in defining the role of a site's characteristics in travel cost models. First, the household production function can offer specific guidance as to how attributes should be introduced. It can also provide a means for judging the consequences of alternative specifications. The most direct of these relates to the so called varying parameter model (see Russell-Vaughan [1982] and Smith-Desvousges [1986]). Desvousges and Smith have argued that when the analyst assumes the site demand parameters are functions of only that specific site's characteristics, this is equivalent (for the case of single recreation service models) to assuming the household production technology is represented with an augmentation function adjusting the contribution of a site's services based on its characteristics, as in equation (5).[7]

$$S_r = \bar{f}_r \left(X_r, h\left(\bar{a}_j\right) \cdot V_j\right) \qquad (5)$$

where: $\bar{a}_j$ = vector of site characteristics at site j
V_j = visits to site j

The implication of this formulation is that individuals consider the effective cost (i.e. travel cost relative to $h_j(\bar{a}_j)$) in making recreation site decisions; select one site based on it being the least costly means of obtaining the largest amount of these constant quality units; and never use other sites. In such a formulation, we would not expect to find substitute sites' prices or attributes in a site demand function.

The second issue arises with characteristics of a site's services. As we noted, the features associated with a site's services are largely the results of the aggregate patterns of use for a site during the period and involve measures of congestion relevant to the activities supported by the site. To adequately include them we must know how congestion affects the services relevant to each recreational activity. For snow skiing the relevant measure may be waiting time for lifts, while for wilderness hiking congestion may have no relationship to conventional time-related measures. Instead, congestion measures are usually based on the number and times of disruptions to solitude (encounters with other parties).[8]

In both examples, the question relevant to the demand model is how does a person know these attributes. In some cases, the characteristics of the site in any potential visit will not be known at the time the recreation decisions associated with selecting a site must be made. Thus, decisions will be based on expectations formed from prior experience. Modeling decisions under uncertainty may be especially important here. (For early recognition of this issue, see McConnell and Duff [1976]). Of course, this is a question of degree. All site characteristics should be measured by what is perceived by prospective recreationists. These perceptions are influential to decisions. (See David [1971] and Bockstael et al. [1987] for further discussion.) Nonetheless, so long as the physical attributes of a site are not markedly affected by others' use, we would expect they could be treated as more certain in relative terms when modeling individuals' choices.

Third, to the extent models seek to isolate nonuse (e.g. existence) values for a site's characteristics, then the specific attributes involved will enter both household production functions and the preference function. At best, travel cost demand models indicate a portion of the value generated by such characteristics. They do not provide information on nonuse values. Thus, if one assumes that the complete use value of a site characteristic is measured from that site's demand function, this implies the analyst is assuming weak complementarity between the site's services and the characteristics. In a household production framework this assumption implies that the site characteristics make no contribution to the recreation service flow without positive levels of use of the site.[9]

Finally, a variation on the augmentation model has been implicitly proposed in the hedonic travel cost model by Brown and Mendelsohn [1984]. More specifically, in selecting recreation sites, the augmentation form of the model implies that the recreationist will select the site with the lowest effective unit cost for a homogeneous unit of a site's services. Define $\overline{TC}$ as the cost of the homogeneous site that serves as a bench-mark, then the travel cost to site j, TC_j, with attributes a_j must satisfy equation (6).

$$\frac{TC_j}{h(\bar{a}_j)} = \overline{TC} \qquad (6)$$

Or rearranging terms, we would expect:

$$\ln TC_j = \ln (h (\bar{a}_j)) + \ln \overline{TC} \qquad (7)$$

A market mechanism might be expected to assure equality of $TC_j/h (\bar{a}_j)$ across all sites. Under these conditions, we could assume a hedonic price function would capture observed differences in site characteristics.

The hedonic travel cost model appeals to this basic rationale without having the equivalent of a market to assure the equality of all terms such as (6). Thus the framework should be treated differently from conventional hedonic models. It offers a new conception of the choice process involving heterogeneous sites - one that focuses on sites' characteristics, but it is not theoretically consistent with either the conventional Rosen [1974] argument for the existence of hedonic price functions or with Desvousges and Smith's adaptation of Lau's [1982] work for input aggregation problems.

Instead, in the Brown-Mendelsohn model an individual is assumed to conceptualize the array of recreation site opportunities as if a cost locus relating travel cost to site characteristics existed. Decisions to visit recreation sites are the intermediate actions required to assure that the marginal rate of substitution between site characteristics in consumption equals the ratio of their implicit marginal costs. These marginal costs are derived from the perceived total cost function for site attributes. This should be recognized as an approximation and not a model that follows consistently from any of the frameworks explained thus far. We return to it further below in describing the conceptual and econometric issues in implementing empirical models based on the travel cost framework.

2.3. Implementing the Travel Cost Methodology

To appreciate the evolution of econometric models based on the travel cost methodology, it is especially important to recognize that the early data for recreation demand analyses consisted of vehicle counts (or frequencies based on entry permit information) by the county of origin of the individuals entering some sites and that was all! All the remaining information was constructed by the analysts involved and "attached" to these visitation records.[10] Hotelling's [1947] suggestion was about all that could be done with this type of information. Distance was typically measured from the site to the centroid of each county. The available summary statistics describing the socioeconomic characteristics of county residents were assumed to be adequate descriptions of the recreationists. Visits were scaled by each origin county's population and interpreted as a rate of use of the site for the "representative" individual (see Cicchetti, Fisher, and Smith [1973]). While several of these studies recognized the need to consider the time costs of travel, the role of substitutes, the tradeoff between trips, and increased on-site time as well as other issues, they were largely constrained to simple models by the available information.

Some specific issues in the use of these data should be highlighted. For the most part, travel time was computed by assuming a vehicle speed with the round-trip mileage estimates. In the absence of income or wage information for recreationists, adjustments for the time costs of travel simply increased the unit cost multiple used to scale distance.[11] Substitute price terms were added, based on knowledge of comparable recreation sites relevant to the perceived (by the analyst) market for the site being studied.[12] There was no specific information on which sites were actually considered substitutes by the individuals involved.

A. Systems of Recreation Demand Models

Confusion over what was needed to consistently measure the benefits from the introduction of a new site or changes in the access (e.g. travel costs) to an existing site initially motivated the development of systems of travel cost demand models (see Burt and Brewer [1971] and Cicchetti, Fisher and Smith [1976] as examples). As Hof and King [1982] argued (see also Ward [1983] and Hof and King [1983]), this complexity in the models and welfare measurement was not necessary for estimating the consumer surplus provided by a change in travel costs, or with added assumptions, the introduction of a new site in an existing system.[13]

However, the systems approach is potentially interesting from another perspective - that of defining the regional nature of recreation markets, as well as for evaluating what actually constitutes a recreation site. For large sites or in the context of marine recreation with distant entry points, this can be an important question. Comparing the demand system approach with separate demand functions that specify which sites' prices will serve to reflect the prospects for substitution is a very different characterization of the regional recreation market than the strategy of pooling observations across origin zones (or individuals for microdata) and across sites within a prespecified region. The latter strategy imposes specific restrictions on the relationship between the effects of price, income, and other demographic factors for each site in the region. The form of these restrictions affects how the variables describing the site characteristics are specified to enter the model.[14] As a rule, these regional models must (because of their structure) abandon prices to measure the effects of substitute sites and instead construct generalized measures for the effects of substitutes, e.g. attractiveness indexes. In Chapter 5 we develop an alternative way to deal with this issue.

In general, these regional models are the product of analyst judgment with a somewhat limited conception of what constitutes a regional recreation market. (See Ziemer and Musser [1979] and Loomis, Sorg, and Donnelly [1986] for discussion of some of the issues involved.)

B. Micro Data

Travel cost methodologies changed substantially with the increased availability of micro level data. While far from ideal, these data sets offer more specific information on the characteristics of recreationists and the recreation choices they made than was previously available with zonal data. Because they are usually based on surveys conducted on site, there are several problems with their use. Of course, it should be acknowledged that some of these issues were also present with zonal data but were not recognized as such until after they were described in the context of analyzing micro data.[15]

These problems usually include at least one, if not all, of the following:

(a) Interviews conducted on site describe behavior of all those who visit the site. This raises a truncation issue (the number of visits is never less than one). Depending on the sampling procedures used, it can also imply endogenous stratification (Shaw [1988]).[16]

(b) The records of trips are less likely to appear as continuous variables and may well need to be treated as count data in the econometric analysis. Further, the actual questions used to acquire the information may have introduced censoring (see Smith and Desvousges [1985], Smith [1988] and Shaw [1988]).

(c) Demand models may also be subject to selection effects (Heckman [1979]) because the probability of visiting the site may be related to factors other than those explaining the level of demands for a site.

(d) Substitute sites are usually not identified in ways consistent with conventional demand models; a next best alternative site is usually requested. This will generally differ across individuals and the specific site corresponding to the next best alternative may not be identified.

(e) The information on trip-taking decisions is usually incomplete - relating either to decisions for the previous season or plans for the current season. In both cases the usage estimates are confined to the site and generally lack detail on the length of each trip, its objectives, and costs.

The first three issues imply that simple regression methods (i.e. ordinary least squares - OLS) applied to micro data are likely to give biased estimates. Indeed, Smith and Desvousges [1985] found substantial differences comparing OLS estimates with those from a maximum-likelihood (ML) estimator that incorporated the truncation at one visit and a censoring at the top end of the scale of visits implied by the question design. For the 22 Corps of Engineers sites they examined, OLS generally overestimated the magnitude of the consumer surplus per visit implied by the estimated coefficients. The differences were generally large, with OLS 3- to 8-times larger than the ML estimates for the same sites.[17]

Maximum likelihood estimators can be defined for situations involving one or more of the first three problems with individual data. Of course, what is needed is the prior specification of the exact model structure, including the stochastic error. That is, we must specify a model to describe the probability that individuals will be present at the site.[18] For example, suppose the demand function is given in equation (8):

$$\begin{aligned} V_{ji} &= f_j\ (\bar{X}_i,\ \alpha) + u_{ji} \quad \text{when } f_j\ (\bar{X}_i,\ \alpha) + u_{ji} > 0 \\ V_{ji} &= 0 \qquad\qquad\qquad\quad\ \ \text{when } f_j\ (\bar{X}_i,\ \alpha) + u_{ji} \leq 0 \end{aligned} \tag{8}$$

where j represents the site. Then the probability an individual will be "in the sample" is given by

$$\text{Prob (sample)} = \text{Prob } (u_i > -f(\bar{X}_i,\ \alpha)) \tag{9}$$

A truncated MLS estimator recognizes that 1-Prob(sample) are not represented, so the density is rescaled to reflect this omission and assure the normalized density function has an area of unity.

In this form, the model implies that there has been a type of selection effect. The form of the effect will differ depending on what we assume. For example, in this case, if we assume u_i follows a normal distribution and that the same factors determine participation and the level of demand, then we can write the conditional expectation $E(V_i|V_i>0;\ \bar{X}_i)$ as:

$$E(V_i | V_i>0; \bar{X}_i) = f(\bar{X}_i, \alpha) + \sigma \frac{\phi(-f_i/\sigma)}{\Phi(f_i/\sigma)} \tag{10}$$

where $\phi(.)$ and $\Phi(.)$ correspond to the standard normal density and distribution functions and σ is the standard deviation for u_i

We simply do not observe nonvisitors. If we could (and this is the problem of the zero visit rates with zonal data), we might choose to represent this as a censored dependent variable (i.e. a Tobit model). This formulation allows for the accumulation of "mass" at the censoring value. The expected demand is now based on both zero and positive visit levels so:[19]

$$E(V_i|\bar{X}_i) = \text{Prob}\ (V_i>0) \cdot E\ (V_i|V_i>0;\ \bar{X}_i) + \text{Prob}\ (V_i=0) \cdot E\ (V_{ji}|V_i=0;\ \bar{X}_i) \tag{11}$$

Substituting from (10) we have:

$$E(V_i|\bar{X}_i) = \Phi(f_i/\sigma) \cdot f\ (\bar{X}_i, \alpha) + \sigma\phi(-f_i/\sigma) + (1-\Phi)\ (f_i/\sigma) \cdot 0 \tag{12}$$

To the extent the participation decision is based on other factors in addition to those reflected in f (.), then we have the Heckman [1979] selection model where the probability in (9) is determined separately from the level of demand.[20] Thus, if Prob (sample) is given by equation (13), then the conditional expectation can be written as (14):

$$\text{Prob (sample)} = \text{Prob}\ (V_i > -\ g\ (Z_i, \beta)) \tag{13}$$

$$E(V_i|V_i>0;\ \bar{X}_i) = f\ (\bar{X}_i, \alpha) + \rho\sigma \frac{\phi(-g_i/\Theta)}{\Phi(g_i/\Theta)} \tag{14}$$

where ρ = correlation of errors in the model describing participation with that for demand

Θ = standard deviation of error for participation model

Heckman's method uses a two-step approach but both participants and nonparticipants must be observed. Without this information, as in the case of on-site surveys, an ML estimator assuming the same factors influence both decisions is the only alternative.

There has been rather limited experience to date with these alternatives because most analyses have been confined to on-site data. In other applications the Heckman approach has been found to be sensitive to specification of the g(.) and distributional assumptions.[21] Smith [1988] compared conventional estimates of the Marshallian consumer surplus derived from a variety of estimators and demand specifications including several different Heckman-type selection models, Tobit, truncated ML and a Poisson regression model for count data. Based on this criteria only, the selection of functional form was more important to the per trip consumer surplus than the estimator, provided the estimator recognized either the missing nonusers or treated them in a censored model. OLS estimates for the full sample - including both users and nonusers - implied a consumer surplus that was twice the size of most of the other estimates.

These findings cannot be generalized. They relate to one site that provides local water-based recreation. The emphasis on local is important because the issues giving rise to important selection effects seem more likely to be important for national sites, what Clawson and Knetsch [1966] described as the resource-based sites.

More fundamentally, these models all suffer from a common limitation. They "account for" problems raised by some individuals choosing not to demand the services of a site (at existing implicit prices). They do not offer a model derived from a consistent theoretical explanation for this outcome. Of course, as we acknowledged at the outset, this alone should not lead us to dismiss them. The issue becomes one of how well the available alternative strategies for approximating behavior will perform.[22]

C. <u>Selecting a Specification for Demand Function</u>

A demand function is a reduced form expression (at the individual level) describing how a person will respond to changes in the parameters to his optimization decisions. Kealy and Bishop [1986] have argued that where possible, travel cost demand models should be derived from specified utility functions. They illustrate the process using an analytically tractable and quite simple specification. As we observed at the outset, given all the other approximations imposed on most applied microeconomic models, there is no reason to require that demand models follow from a specific utility function.

Of course, there is value in the consistency in parameter relationships imposed by the analytical deviation of the demand function from a utility function. Nonetheless, for models involving the allocation decisions associated with small components of a consumer's budget, as outdoor recreation is likely to be, our understanding of the important issues to these decisions may not be greatly enhanced by starting with a utility function defined over a very restricted set of choice variables. More important issues may be associated with the constraints to an individual's choices and the time horizon for them to be made. How then are the decisions on demand model specification to be made?

Past literature has tended to use linear, semi-log (with the log of the dependent variable) and double-log specifications. Most studies adopt one of the last two cases. The Ziemer et al. [1980] comparison using Box-Cox methods to isolate a functional form for a travel cost demand function involving warm water fishing found that a semi-log model would be selected using a Box-Cox search criteria. Moreover, the consumer surplus estimates per person per trip for the semi-log fell in the middle of those of linear and quadratic models. In contrast, in an earlier study (Smith [1975]) using testing for non-nested hypotheses, Smith found that neither the semi-log or double-log models would have been judged acceptable.

There are important differences between these two evaluations. Ziemer et al. [1980] used micro data for individuals engaged in warm water fishing in Georgia to estimate a regional travel cost model. The Smith [1975] analysis used zonal data for a single site, the Desolation Wilderness Area in northern California. Thus, both studies report fairly specialized findings. The problems of selecting a functional form are especially difficult because of the interaction effects of the decisions selecting a form and the estimators that are used to account for special features of the data. Each type of data problem can preclude some forms.

There are no unambiguous answers for travel cost demand models. Using flexible specifications, examining whether the results of interest are sensitive to the functional form selected, and treating specification tests as crude diagnostics of inappropriate forms remain the only guidance that can be offered based on the current status of available research.

D. Random Utility Model (RUM)

The RUM approach to describing recreation decisions offers another way of modeling that explicitly addresses the problems posed by zero visits to some sites. To do so it introduces four important assumptions. First, the time horizon is altered from the season, or a perspective that would allow multiple trips to be selected at different sites, to a single-trip occasion. An individual can then only select one recreation site for each trip occasion. Second, the model assumes these decisions are independent across trip occasions. Third, the model describes the extensive margin of choice (in McFadden's [1974] terms). It assumes individuals are comparing the utility that could be realized from all other related decisions, conditional on the selection of a recreation site. Thus, if we define v(.) as the overall indirect utility function corresponding to one of the characterizations of individual behavior given earlier, it is the maximum of a set of functions $v_k(.)$, defined conditionally on the selection of each site. Thus, these v_k's include only the implicit price (represented in equation (15) as τ_k's) of the selected site.

$$v(y, \tau_1, \tau_2, \ldots \tau_D) = \text{Max } [v_1 (y, \tau_1), v_2 (y, \tau_2) \ldots, v_D (y, \tau_D)] \qquad (15)$$

Of course, other prices would be included. Depending on how we assumed recreation decisions were made, y could be income or the total expenditures on a component of the individual's budget.

The model seeks to describe the probability that an individual will select any one of the available sites. This leads to the fourth assumption. An individual's conditional utility function is assumed to be stochastic from the perspective of the analyst. That is, we can continue to maintain that the household production framework describes behavior and use it to specify the conditional indirect utility function that would arise from maximizing one of the forms of the consumer choice problem described earlier (provided we assume the time horizon is restricted to one choice). This conditional indirect utility function is the deterministic component of preferences. To it we add an error that can vary by individual, recreation site, or both. The error is usually described as reflecting the analyst's failure to know all the factors (either individuals' characteristics or sites' characteristics) that could influence the decision process.[23]

Site selection involves comparing these stochastic utility functions for each possibility and picking the one that yields the highest utility as in (16a) and (16b).[24]

$$\text{Prob(site} = k) = (\text{Prob } (v_k(.) > v_j(.)) \; j=1,\ldots,D \qquad (16a)$$

With $v_k\ (y,\ \tau_k) = U_k(y,\tau_k) + \epsilon_k$, we have:

$$\text{Prob(site} = k) = \text{Prob } (U_k - U_j > \epsilon_j - \epsilon_k) \qquad (16b)$$

The RUM model maintains that the ϵ_k's follow independent, identically distributed, extreme value distributions. This assumption yields a simple form for the probability that any individual, i, will select site, k, as in (17). This is simply the multinomial logit model.

$$\text{Prob (site}_i = k) = \frac{e^{U_{ki}}}{\sum_{s=1}^{D} e^{U_{si}}} \qquad (17)$$

This simplified form is not without costs. It imposes significant restrictions in terms of its characterization of the choice process. Referred to as the independence of irrelevant alternatives (IIA) assumption, this formulation implies the probabilities of choosing site k in comparison to site n will depend exclusively on the attributes and prices of these alternatives and not on the other available possibilities. This is easily demonstrated from (17) by taking the ratio of the probabilities of going to any two sites. These will depend <u>only</u> on the arguments of the conditional utility functions for these two sites.

Because it is likely to be implausible for most choice situations, we again face the issue of the quality of the model as an approximation.[25] To overcome this restriction, McFadden proposed the generalized extreme value form for the errors. This amounts to an assumption that decisions take place in a sequence. To our knowledge, the most extensive model of this type developed to date is by Hanemann and Carson [1987], who have used this type of structure in analyzing sport fishing demands. The sequence of nested choices in their model involves, at the top level, a decision of how many trips occur in a week. Then, given a specified number of trips, a target fish species for the current trip is selected. Following that decisions, the fishing site is chosen.[26] This structure allows some correlation between alternatives and thereby avoids the IIA assumption. This specification leads to probabilities of the form given by (18).

$$\text{Prob}\ (\text{site}_i = k) = \frac{e^{U_{ki}}\, G_k\left(e^{U_{1i}}, e^{U_{2i}}, \ldots, e^{U_{Di}}\right)}{G\left(e^{U_{1i}}, e^{U_{2i}}, \ldots, e^{U_{Di}}\right)} \tag{18}$$

where for a two-stage nesting, the function G( ) is:

$$G=\sum_{s=1}^{L} a_s \left[\sum_{k \epsilon S_s} e^{U_k/(1-\sigma_s)} \right]^{(1-\sigma_s)}$$

G_k = partial derivative of G with respect to k_{th} argument

Nesting adds structure to the derivation of the probabilities. In a two-level nested model the probability of a site selection would involve selection of a set of sites organized on some criteria (e.g. saltwater versus freshwater, bank versus boat, etc.) and then given selection of a type, a site within that group. Thus the π's become products of probabilities with the number of conditioning steps depending on the number of levels.

These models are estimated with maximum likelihood methods using the assumption of independence in individuals' decisions and, to the extent there are multiple trips per person, independence across trips as well. If π_{ki} is used to designate the probability an individual, i, will select site, k, then the likelihood function is given as equation (19).

$$L = \prod_{k=1}^{D} \prod_{i=1}^{N} \pi_{ki}^{t_{ki}} \tag{19}$$

N = Sample Size
D = Number of Sites
t_{ki} = Indicator variable (0 or 1) depending on whether individual i used site k.

Because the principal connection between levels is the inclusive value, consistent (but not efficient) estimates can be derived using a sequential scheme, maximizing the conditional likelihood function associated with each leg of the tree, starting at the lowest level and working up to the tree. The inclusive value conveys the relevant information about the available choices for the next higher level. Defined for equation (18) in equation (20), the inclusive value is a measure of the value that is potentially derived by selecting from among the alternatives given in each leg of the nested structure.

$$I_{\ell} = \ell n \left[\sum_{k \epsilon S_{\ell}} e^{V_k/(1-\sigma_{\ell})} \right] \tag{20}$$

The ability to structure the decision sequence eliminates an important limitation of the RUM model. It does not, however, completely avoid the issue. The nesting structure itself should be treated as a maintained hypothesis. We impose a decision sequence to avoid the one implied by the simple RUM framework. To our knowledge no studies have evaluated the implications of alternative structures for the description of recreation decisions.

E. Including Site Attributes

An important aspect of the empirical issues addressed by these discrete choice models has been the role of site characteristics for recreation decisions. Differences in the characteristics of sites have been argued as the explanation for the substitute price terms in travel cost models. Because these attributes affect an individual's ability to "produce" certain recreational activities, they substitute at different rates in production. This is reflected by the cross price terms in conventional demand models. Moreover, this argument would imply that where site substitution effects are important influences to observed behavior, we might expect a version of the random utility models would be superior to the travel cost model because these frameworks allow the analyst's description of the decision process to take account of the full range of available alternatives.

The other possible models described in our earlier discussion of the theory underlying the conventional travel cost demand model include:

- the varying parameter model
- the regional recreation demand model
- the hedonic travel cost model

As that earlier description indicated, the first two are variations on the basic travel cost method. The first estimates separate demand models for individual recreation sites and uses the estimated parameters as data for second stage models. It hypothesizes that the parameter estimates vary because of differences in the recreation site's characteristics. The second pools data across sites and imposes a structure for the influence of site characteristics by specifying interaction terms between the conventional arguments (e.g. price, income, etc.) and the relevant characteristics.[27] Table 2.2 compares the basic structure of each.

A comparison of the first and second columns indicates that the two models can be algebraically equivalent (by substituting the expressions for demand parameters into the site demand model). However, their applications have been different in one important respect. Varying parameter models group recreation sites that have facilities to support comparable recreation anywhere in the United States, implicitly assuming that preferences are stable (if the demand functions are correctly specified). Therefore they assume that differences in demand parameters across sites supporting the same recreation must be the result of the respective sites' attributes.

In contrast, the regional demand models restrict the pooling of site visitation information to those within a specified region. Often they impose the further restriction that the sites must support comparable recreational activities. The definition of that region is a central issue in the application of these methods.

The third alternative to the discrete choice model (given the fourth column of Table 2.2) is the hedonic travel cost model. As observed earlier, the theory underlying this model uses a format comparable to the varying parameter framework. However, the focus is directed to estimating the demand for site attributes. Visits to recreation sites are the intermediate steps in the acquisition of these characteristics.

Because there are no markets to define the price (travel cost) functions hypothesized to describe how individuals perceive the recreation alternatives available to them, this should be regarded as a maintained hypothesis. It implies each individual would face a unique price function. The analyst derives an estimate of how each individual perceives the marginal cost of acquiring an additional unit of each characteristic from that price function. For linear price functions this will be constant for an individual, but will vary across individuals as a result of differences in their recreational opportunities.[28]

The second stage in this model is the estimation of demand (or inverse demand) models for each characteristic using these estimated marginal prices. Mendelsohn [1984] has argued for inverse demand functions because the marginal prices are random variables.

A wide variety of issues arise with the implementation of the hedonic travel cost model. Three are especially important.[29] First, the model

TABLE 2.2

A Comparison of Models Implementing the Travel Cost Methodology

	Travel Cost Demand[b]				Random Utility Models	
	Simple	With Costs of Travel Time	Varying Parameter	Hedonic Travel Cost	IIA	Nested Logit
Behavioral Model	$V_i = a + bTC_i$ $+ cY + \Sigma d_j TC_j$ $(b<0)$	$V_i = a + bTC_i$ $+ cY +$ $\Sigma d_j TC_j + ew$	$V_i = a + bTC_i$ $+ cY$ with $a_i = \sigma_o + \Sigma \sigma_k A_{ki}$ $b_i = \beta_o + \Sigma \beta_k A_{ki}$ $c_i = \theta_o + \Sigma \theta_k A_{ki}$ i = site k = characteristic s = individual	$TC_{is} = \gamma_{os}$ $+ \Sigma \gamma_{ks} A_{kis}$ $\gamma_{ks} = \delta_o + \delta_1 \bar{A}_{ks}$ $+ \delta_2 Y + \delta_3 \gamma \ell_s$ k = characteristic i = site s = individual	$P_j = \frac{\exp(A_o TC_j + \Sigma A_k A_{kj})}{\Sigma_{\ell} \exp(A_o TC_{\ell} + \Sigma A_k A_{k\ell})}$ P_j = probability of visiting a site alternative	$P_j = \frac{\exp(A_o TC_j + \Sigma A_k A_{kj}) \, G_j(.)}{G(.)}$ where G_j = partial derivative of G with respect to jth argument.
Time Horizon	Season	Season	Season	trip - occasion	trip - occasion	trip - occasion
Implicit Assumptions	<u>Individual Data</u> V_i = visits that are planned over season; <u>Zonal Data</u> V_i = total visit/population, a rate of visits; see equation in text. <u>Selection of Substitute Sites</u> is an issue that is often arbitrary or reflected by an index. <u>Functional Form</u> usually selected by convenience, fitting criteria or ease of welfare measurement. <u>Price</u> TC can include time cost of travel, but on-site time per trip constant	Same as simple model; plus question of treatment of wage as one opportunity cost; McConnell-Strand estimate opportunity cost as kw where $k = e/b$ <u>Price</u> <u>TC</u> not include time costs of travel	Same as simple model; plus no role for substitutes, select a best site because quality, as measured by attributes, augments effective site services	Recreation opportunities perceived as by a cost function linking trip cost to site characteristics; linear price function for simple inverse demand functions for characteristics; treatment of negative prices an issue; meaning of substitution of characteristics	Income linear and equal effects for non-stochastic component of utility functions usual assumption; IIA; stochastic error enters from incomplete information; decisions independent across trip occasions <u>Price</u> can include travel and time cost of travel	income linear in non-stochastic component of utility function but can be different across nests; relaxes IIA; decisions independent across trip occasions; nesting structure implicit in G ( ) is maintained <u>Price</u> can include travel and time cost; can include on-site time in nest
Data Requirements	Individual or zonal	Individual[c]	Individual or zonal with observations of several sites	Individual with observations on individuals' usage of different sites; preferably a household survey	Individual data	Individual data

[a]For simplicity demand models use linear form. Selection of functional form can be varied. Variables used in table are V_i = visits to recreation site i; TC_i = travel cost to site i, can include opportunity cost of time (see price assumption); Y = income; w = wage rate; A_{ki} = amount of attribute k at site i; P_j = probability of visiting site j on any particular trip occasion.

[b]Models could be expanded to include other determinants; varying parameter cannot easily include substitute prices without proposals for consideration.

[c]This assumption required for use of wage data.

implies that each individual should have a unique price (travel cost) function. Brown and Mendelsohn [1984] suggest that in applications individuals can be grouped into origin zones with comparable travel costs to each site that is identified as part of the available supply. Consequently, this is the way the model has been applied. However, there is no reason to believe the travel costs will be comparable across individuals when the costs of travel time are included in the implicit price. We can expect the opportunity cost of time will vary across individuals. In most applications, this will be an important component of trip costs. Moreover, even if time costs are ignored, the definition of origin zones is not clear. Smith and Kaoru [1987] found for local water-based recreation that while the definition of origin zone did not appear to greatly affect the estimated demand models for site characteristics, it was an important influence on benefit measures estimated from these functions.

Second, the model does not specify the decision horizon for its description of the demands for characteristics. This has implications for the quantity measure for each site attribute used in demand (or inverse demand) models. The Smith and Kaoru [1987] results indicate this factor was quite important to the model's benefit estimates. Either a single trip or seasonal orientation would seem possible. Of course, this decision requires that we address an important aggregation issue - how do we aggregate the crude proxies we have for quality features of each site - crowding measures, catch rate, technical or perception-based measures of site quality, etc?

Finally, the model does not provide a consistent linkage between the trip-taking, time-on-site, and characteristic choice decisions. Table 2.2 provides a comparable summary of issues with each of the other three methods for measuring the role of site characteristics. Because none is ideal, comparative evaluations of their respective performance patterns will be important to understanding the practical significance of each method's assumptions with specific types of applications. Unfortunately, these types of evaluations are in the early stages of development.

Three recent studies are noteworthy. Bockstael, Hanemann and Kling [1987] have compared two of the approaches (discrete choice versus hedonic travel cost) for valuing water quality improvements. Their results favored a random utility model using a nested formulation. This conclusion was based on the plausibility of their benefit estimates and the sensitivity of the estimates to modeling decisions.

There are limits to what can be learned from comparisons with actual data because we never know the true values for the benefits being estimated. Learning is limited to evaluations of the sensitivity of the conclusions to modeling decisions. For this reason, the second set of papers is especially interesting as an example of an alternative strategy. Kling [1988] and Kling and Weinberg [forthcoming] have proposed a new approach - the use of Monte Carlo methods to simulate data comparable to the type available for recreation demand models in evaluating the various modeling approaches. Their evaluation is based on the quality of each method's benefit estimates judged in comparison with the known true value of quality improvements. Kling's applications are the first in a promising line of research. Using a Stone-Geary utility function in Kling [1988] and a modified translog that allows for generalized corner solutions in Kling and Weinberg [forthcoming] to characterize preferences and experiments where the cross-site price and site substitution effects varied, these experiments offer the first direct guidance on how the character of the true preference structure influences these models as approximations to that structure. When the effects of cross price and quality-based factors motivating site substitution were small, Kling's experiments indicated a model similar to a regional demand (or the Russell-Vaughan version of the varying parameter) model provided superior estimates of the value of quality improvements in comparison to the simple (logit-based) random utility framework. Both models understated the benefits. The average errors were fairly large for both, with the RUM model averaging 12 percent smaller estimates of the gain than a weighted least squares estimate of the pooled, varying parameter model.[30] When substitution is important (Kling and Weinberg) and/or the fraction of zero visits increases, then the logit-based random utility model is clearly superior with errors in the welfare estimates about 10 percent of the true values. With this utility function most models overestimate the true welfare measures. Only the semi-log specifications using Tobit understated the true welfare measures. This was only true in the experiment with few corner solutions.

Of course, these results are simply the beginning. More detailed experiments will be needed to understand how each modeling strategy performs under each set of conditions. The size of the samples will need to be expanded and the work of Bockstael and Strand [1987] on what we would anticipate for the variability in welfare measures should be used in judging the sampling results. It will be desirable to perform experiments comparable to what Guilkey et al. [1983] report for production functions to compare how all models perform when the true and specified functional forms are varied.[31]

2.3 Summary

This chapter has provided an overview of the conceptual basis for the travel cost recreation demand model, as well as the methodologies used to implement the model in practice. One of the most important conclusions we draw from this summary is that the data available in any particular example limits in important respects which models can be applied to describe an individual's recreation choices. As we observed in the introduction, the existence of a detailed, on-site survey conducted for the 1981 and 1982 recreational fishing seasons under the auspices of the N. C. Sea Grant Program was essential to the design of this research.

The basic model developed for our analysis will be a modification to the regional travel cost frameworks described earlier. Because the Sea Grant data identify specific entry points to the Albemarle-Pamlico Sounds, it is possible to define a composite of these entry points as the equivalent of a single recreation site. Given the fact that these points are typically boat ramps providing access to one of the sounds, this grouping of ramps in geographic proximity to one another seemed quite plausible.[32] Moreover, with information on the characteristics of these entry points (and variation in them across those points defined to constitute an aggregate site), it may be possible to learn how variations in site characteristics influence demand. Of course, it is important to acknowledge that in order to develop these insights, we are making strong assumptions about the nature of the typical recreationist's demand for these sites. Demands are implicitly restricted to be the same (i.e. have the same true parameters) for those variables that are not specified in terms of the site characteristics.

As we argued, this assumption can be justified as theoretically plausible, given the nature of the activities. However, it is important to recognize that a strategy to permit pooling observations across entry points was also a practical requirement. There was simply not a sufficiently large sample to allow estimation of separate demand models for each entry point. We return to a description of the other potential alternative modeling strategies with these data in the last chapter.

Chapter 2

FOOTNOTES

1. Over forty years ago (in 1947), Harold Hotelling wrote a letter in response to an inquiry from the National Park Service about how policy-makers might develop measures for the benefits provided by recreation sites. That letter and subsequent applications of its suggestions by Trice and Wood [1958] and Clawson [1959] started a major line of research in resource and environmental economics associated with travel cost recreation demand models. Hotelling described the approach as follows:

> Let concentric zones be defined around each park so that the cost of travel to the park from all points in one of these zones is approximately constant. The persons entering the park in a year, or a suitable chosen sample of them, are to be listed according to the zone from which they came. The fact that they come means that the service of the park is at least worth the cost, and this cost can probably be estimated with fair accuracy....A comparison of the cost of coming from a zone with the number of people who do come from it, together with a count of the population of the zone, enables us to plot one point for each zone on a demand curve for the service of the park. By a judicious process of fitting, it should be possible to get a good enough approximation to this demand curve to provide, through integration, a measure of consumers' surplus...

In the intervening period and especially in the last decade, an extensive literature has developed on the issues associated with modeling recreation demand. The travel cost method has emerged as one of the most robust and reliable of the indirect approaches for valuing nonmarketed resources.

A number of other economists were also asked for suggestions at the time. Apparently the National Park Service ignored Hotelling's suggestions initially. They did not appear to play a significant role in modeling recreation demand until the later work of Clawson [1959] illustrated and popularized the method.

We are grateful to Yoshi Kaoru for locating these historical materials for us.

2. The demand functions for trips would have the same arguments in both cases (assuming the opportunity costs of time) were related to the wage rate, but the theoretical properties that could be derived to describe demand would be less clear-cut.

3. Empirical tests of the approach using micro-data (Smith, Desvousges, and McGivney [1983]) and more recently using zonal data (Hof and Rosenthal [1987]) have indicated widely disparate values for the scaling parameter proposed by Cesario and Knetsch when estimated using the McConnell-Strand framework.

4. To our knowledge, David Gallagher was the first to raise this issue in unpublished notes prepared at the University of North Carolina, Chapel Hill.

5. Wilman's [1980] attempt to distinguish the commodity and scarcity values of time used this argument.

6. Smith and Kopp [1980] proposed using the cusum of squares test together with ordering the sample (from a zonal data base) by the distance of each origin zone from the recreation site. They argued that violations in the travel cost model's assumptions became more likely as the distance between the site and the origin zone increased.

7. This approach adapts a framework proposed by Lau [1982] for describing the role of the characteristics for a material aggregate. Also, for simplicity we have ignored decisions about on-site time.

8. These features of the experience were identified based on extensive research on the features of wilderness recreation that were judged to be important to recreationists by Lucas [1964] and Stankey [1972].

9. Bockstael and Kling [1988] have recently proposed a generalization to the weak complementarity assumption between quality and a single commodity to include several goods, as for example all water-related recreational activities and water quality.

10. See Bockstael and McConnell [1984] for a more detailed discussion of the effects of the aggregation underlying zonal models for travel cost demand models based on them.

11. For example, if d designates the round-trip distance, s the speed of travel, c the unit (vehicle-related) costs per mile, then travel time, T, is:

$$T = \frac{d}{s}$$

and the assumed opportunity costs of travel time, say θ, can be adjusted to the multiplier for distance. Total costs of a trip, m, are then given by:

$$m = cd + \theta \left(\frac{d}{s} \right)$$

$$= \left(c + \frac{\theta}{s} \right) d$$

12. This is an important issue to be developed in more detail below. See Caulkins, Bishop, and Bouwes [1985] for discussion in the two-site case of the effects of omitting the effects of substitute sites' prices on the estimate from travel cost demand models.

13. Of course, this does not resolve the question of which site to use. Prior judgment must be used to select a demand function (and therefore a site) that is assumed to be identical to what the new site would have.

14. This contrasts with the Vaughan-Russell [1982] version of the varying parameter model because their specification derives the estimating equations assuming all of the parameters of the demand function are functions of site characteristics.

15. The most important of these is what to do with origin zones with zero visitors and how many of these zones should be included in the sample. This was the motivation for the Smith-Kopp [1980] analysis. Most studies with zonal data have argued for a tobit estimator. This does not resolve the question of how many to include. This question is again one of the extent of the market.

16. An important limitation to the implementation of corrections for endogenous stratification is the requirement that the estimator specify how recreationists were sampled in relationship to their probabilities of visiting. The only empirical example where such adjustments have been incorporated in the estimates is Morey, Shaw, and Rowe [1988].

17. A semi-log model was used for the demand models. In one case the estimates were over twenty times larger.

18. The Brown et al. [1983] proposal to aggregate micro-data to a zonal format does not resolve this issue. See Bockstael and McConnell [1984] for a detailed discussion of the effects of aggregation.

19. This argument was originally developed for the micro case by Bockstael and McConnell [1984]. Bowes and Loomis [1980] used a related argument with zonal data to develop an adjustment for heteroscedasticity.

20. This framework is analogous to the early proposals for a two-step approach for modeling participation decisions. See Davidson, Adams, and Seneca [1966] and Cicchetti, Seneca, and Davidson [1969] as examples. There are, however, some important differences. In these examples, the analysis was based on population surveys and respondents' stated participation in activities without explicit discussion of where those activities took place.

21. Criticisms of the selection framework have been based primarily on its sensitivity to the specification of the first-stage probit model and distributional assumptions (see Goldberger [1983] and Little [1985].

22. Experimental studies comparable to Kling [1988] will be needed to evaluate the practical importance of these problems.

23. It is possible to incorporate some of the effects of demand uncertainty in models using the travel cost methodology. Morey, Shaw, and Rowe's [1988] analysis is an example of this possibility. They assume the stochastic elements in their random utility model reflect uncertainty affecting the individual's decisions and not simply the analyst's ignorance.

24. For notational simplicity, I have dropped the subscript to identify individuals.

25. It is possible to adapt the Hausman specification error test to test the independence of irrelevant alternatives property. See Hausman and McFadden [1984] and McFadden [1987] for further discussion. Kaoru [1989] provides a detailed example of its implications for the definition of the recreation site.

26. Other recent examples of the nested logit framework for marine recreation include Bockstael et al. [1986], Milon [forthcoming], and Kaoru [1989].

27. One could jointly estimate the model with a pooled sample as Saxonhouse [1977] proposed. However, the issues associated with model selection become exceptionally complex in a pooled framework. This arises because all variables specified to influence demand in principle interact with site characteristics once these second-stage equations are substituted into the first-stage demand models.

28. Differences in the opportunity costs of time across individuals will also lead to differences in their respective marginal costs for increments to specific site characteristics.

29. A specific issue with implementation that has been found to lead to substantial differences in estimates of the demand and valuation of site characteristics is the treatment of negative marginal costs. There is no guarantee that the first-stage price equations will yield uniformly plausible estimates of the marginal cost for each characteristic.

Bockstael et al. [1987] argue that dropping negative estimates is essential. In contrast, Mendelsohn [1984] suggests that because they are random variables, this can be expected and provides one reason for using an inverse demand specification in modeling the demand for a site's characteristics.

30. It should be acknowledged that a much greater number of replications of each experiment will be needed to gauge the effects of modeling assumptions on the small sample distribution of welfare measures. A minimum of 100 to 500 replications has characterized most other studies of this type used in evaluating neoclassical cost functions (see Guilkey et al. [1983] as an example).

31. A more detailed discussion of the benefit estimates by type of resource is available in Bockstael et al. [1988].

32. We describe it in more detail in Chapter 5.

Chapter 3

A Selective Review of Past Empirical Analysis of Marine Recreational Fishing

3.1 Introduction

Until quite recently, the available empirical results for marine recreational fishing (with the exception of salmon fishing) have been quite limited. However, this has changed with the recent literature. As we observed in the first chapter, the 1987 reauthorization of the Clean Water Act, along with increased concern over the conflicts between commercial and recreational uses of marine fisheries, has led to a variety of new empirical analyses.

The purpose of this chapter is to summarize a representative sample of the empirical studies of individuals' demands for and valuation of marine recreational fishing. First we review the available literature from the perspective of judging its suitability for developing estimates of the value of quality changes in the Albemarle-Pamlico Sounds. This effort updates the earlier Smith-Palmquist [1988] review. From this overview we conclude that while the past several years have seen substantial advances in the empirical information available on the value of marine recreational fishing, the results are typically specific to the local conditions characterizing each study. Equally important, the models have been much less successful in isolating the values of the quality changes that we anticipate would accompany estuarine management.

In some cases policy needs have made it necessary to distill estimates of the value of recreational activities. One such study, Walsh et al. [1988], was recently completed for use in the Forest Service's planning process. While it covers several of the same studies we discussed, because of the objectives and design of the Walsh et al. review, we have summarized this work separately. Each study's results were adjusted based on a panel of experts' consensus judgments on the best modeling practices in an attempt to construct some standardized measures of a representative consumer's value per activity day. This work was prepared as part of the U. S. Forest Service's efforts to incorporate valuation information in the resource planning activities that are required by the multiple-use and sustained-yield legislation governing the management of public lands.

Section 3.2 develops our review of a representative sampling of these studies based on primary sources. In section 3.3 we summarize the Walsh et al. review. Section 3.4. summarizes the issues relevant from both reviews for our own study of the Albemarle-Pamlico Sounds.

3.2 An Overview of Selected Demand Studies for Marine Recreational Fishing

Table 3.1 summarizes the key features of nine studies of the demand for and/or valuation of marine recreational fishing. Two report the results of travel cost demand models (McConnell [1979] and Bockstael, McConnell and Strand [1987]), four describe random utility models (Morey, Rowe and Shaw [1987], Bockstael et al. [1986], Milon [forthcoming], Bockstael, McConnell and Strand [1988], and Hanemann and Carson [1987]), and the remainder report results from contingent valuation surveys.

It is important to acknowledge that each study had fairly specialized objectives beyond simply valuing marine recreational fishing. McConnell's [1979] analysis was primarily intended as a theoretical analysis demonstrating the importance of recognizing that the catch rate experienced by each

TABLE 3.1

Highlights of Selected Studies of the Demand for and Valuation of Marine Recreational Fishing

Study	Date	Location	Type of Fish	Model	Value
McConnell [1979]	Unknown	Rhode Island	Winter Flounder	Travel Cost Household Production	$233 (per season) 515 (per season)
Bell, Sorenson and Leeworthy [1982]	1980-81	Florida	All Species	Contingent Valuation	$743 (annual WTP)
Bockstael, McConnell and Strand [1987]	1980	Chesapeake Bay	Striped Bass	Travel Cost	$69-190 (per season)[a] $10-16 (catch rate improvement)
Morey, Rowe and Shaw [1987]	1981	Oregon	5 Species	RUM[b]	$0-35 (per season)[c]
Bockstael, Graefe, Strand and Caldwell [1986]	1985	South Carolina	King Mackerel Spanish Mackerel Black Sea Bass	Contingent Valuation RUM	$328 (per season)[d] $195 (per season)
Thompson and Huppert [1987]	1985-86	San Francisco	Mix of Species [Salmon] [Striped Bass]	Contingent[e] Valuation	- 50% WTP $33[f] +100% WTP $41 - 50% WTA $82
Milon [Forthcoming]	1985	Dade County Florida	Mix of Species	RUM	$1.60-1.80 (per person per trip for new artificial reef)
Carson, Hanemann, and Wegge [1987]	1986	South Central	13 groups of species including salt- and freshwater species: 7 types of salmon 5 types of trout 13 other species or species groups	RUM	$.30 to $21.47 per summer trip occasion by site/species classes and $.01 to $11.03 per winter trip occasion by site
Cameron [1988b]	1987	Coastal Texas	Average catch rate measures by species, year, time, and location	Discrete Choice CV	$1,857-5,132 for complete loss of access to fishery (per person) $19-52 for loss of access 10% of time

Study	Date	Location	Type of Fish	Model	Value
Bockstael, McConnell & Strand [1988]	Nov/Dec 1987	Florida (Atlantic Coast)	Three classes: Big game -- billfish, marlin, tuna; Small game -- bluefish, mackerel; Bottomfish -- sheepshead, snapper	RUM/Nested Logit model with model and species choice then selection of one of nine sites, defined as aggregates	20% increase in the success rate per trip occasion; Small game for shore or boating \$.33; Nontargeted small game \$.32; Bottom: Boat catch rate \$1.27; Big game/boat \$1.56

[a]These estimates were calculated from the authors' reported tobit estimates using

$$CS = -\frac{q^2}{\hat{\beta}},\ \text{with } q = \text{measure of quantity demand and } \hat{\beta} \text{ the estimated coefficient for travel costs } (\hat{\beta} < 0).$$

The range corresponds to the range in average q's for each of the four areas of the Chesapeake included in the survey. The catch rate improvement is for an increase from the average catch rate (3.5) to the highest catch rate at the lowest and highest levels of use.

[b]RUM designates a random utility model which can have various specifications. Morey, Rowe and Shaw include travel costs and site specific catch rates and consider the possibility of not fishing at any site in a given period.

[c]This is an <u>ex ante</u> value for the Hicksian compensation variation for elimination of salmon fishing Clatsop County. The range arises from variation across the county of origin of the fishermen.

[d]This value refers to the value of an artificial reef for marine fishing trips during a season.

[e]Questionnaire asked about fishing trips using combination of intercept and mailed questionnaires. Valuation questions used as part of CV analysis refer to salmon and striped bass.

[f]Questions asked for willingness-to-pay (WTP) to avoid a certain percent decline in catch rate (designated with negative sign and WTP); willingness-to-pay for certain percent increase in catch rate (designated with positive sign and WTP); and compensation for certain percent decline in catch rate (designated with negative sign and willingness-to-accept (WTA)).

individual reflects both the quality of the fishing experience and the effort expended in fishing. Under this view individual catch rates are endogenous variables. Thus, the two models described in the table for his study, travel cost and household production, are distinguished by whether the process is modeled as a jointly determined set of decisions with trips and catch determined from an optimization process. It is important to note that in this case McConnell argues for interpreting trips as a measure of the output of the recreational activity (fishing) and not a measure of site usage. Because the ideal quality measure for fishing (the stock of fish) is unobservable, the catch rate must be used as an alternative measure. Unfortunately, this measure reflects the effects of the fish stock as well as the effort devoted to fishing. It is therefore an endogenous variable.

McConnell's theoretical analysis clearly identifies the potential for biased estimates when the catch rate is treated as if it reflects the quality of the experience. To illustrate the difference he used a small sample (56) of Rhode Island fishermen and their decisions on fishing for winter flounder. The estimates for consumer surplus (evaluated at the mean values of the variables) for the fishing experience from a simple, linear travel cost demand model versus a linear two-equation (fishing and catch-rate) system are quite different. However, the estimates of parameters in the two-equation model do not indicate that the effects he suggests should be important were statistically significant determinants of behavior.

The Bockstael, McConnell, and Strand [1987] travel cost analysis involved striped bass fishermen in the Chesapeake area. Of the total surveyed (760), 184 fished for striped bass in 1980. While their model was described as a site demand, the data used to estimate it were pooled across sites. An alternative interpretation of the framework is that it is another way of describing a regional travel cost model. However, in contrast to those models described in Chapter 2, where different individuals' experiences at different sites are pooled to describe the "typical" demand for one of a set of sites, each person's experience in using different sites is first aggregated. Then this aggregate usage measure is used to describe the quantity demanded. Their analysis used records for the season and included all variable costs and time cost in the price of a visit. When an individual's season demand involved more than one site, a price index was constructed to attempt to capture the relevant price for the mix of trips taken. Moreover, the price indexes constructed for those not using sites do not seem to accurately reflect the implicit costs faced by each individual. Their model includes own price effects, the individual's catch rate based on his (or her) experiences over the season, dummy variables for different types of fishing equipment, and the fishing/hunting budget (assuming weak separability of the individual's underlying preference function). Tobit estimates of the model provide strong support for a conventional demand framework.

We used these results to estimate the average individual's consumer surplus for a fishing experience. Our range was derived using the range-of-use levels across the four areas identified as part of the region, with the lowest in Sussex, Delaware (6.8 days) and the highest in Southeastern Chesapeake (11.3 days). These estimates are substantially lower than McConnell's earlier results.

It is also possible to use their model to estimate the value of an improved catch rate. To illustrate the implications we postulated an improvement from the overall area-wide average catch rate (3.5) to the highest regional catch rate in the sample (4.9). Valuing this improvement at the lowest and highest rates of use, we have a range of values for the quality improvement of $10 to $16. Adjusting for the effects of inflation, these estimates would be roughly comparable to the contingent valuation results for improvements in the catch rates for striped bass obtained by Thompson and Huppert. (Their contingent valuation study is described in more detail below.)

Unfortunately, data problems required the use of days rather than the theoretically preferred variable, trips, as their quantity measure. While the authors did consider the effects of using an expected catch measure for those with positive levels of use,[1] they did not consider the simultaneity question raised earlier by McConnell.

The Morey, Rowe, and Shaw study appears to be the first attempt to use a detailed random utility model (RUM) to describe marine recreational fishing. In contrast to both McConnell [1979] and Bockstael, McConnell, and Strand [1987], this study does distinguish fishing sites using seven coastal counties. Vehicle-related travel costs, the time costs of travel (priced at the minimum wage for all individuals), together with on-site mode and lodging costs per trip are included in the estimated costs per trip.

Each individual is assumed to select a site and a mode of fishing (i.e. on manmade structures, beach and bank, charter boat, and private boat). The costs of trips by site and mode and species-specific catch rates (i.e. salmon, perch, smelt and grunion, flat fish, and rockfish/bottomfish) were the specified determinants of individuals' decisions.

While the paper does not report individual tests for the determinants of site/mode of fishing choices, the authors do indicate that the model was preferred over a purely random allocation of individuals over the choices.

Equally important, the estimates were consistent with the simple decision process envisioned by the logit form of the random utility model.

The second RUM study summarized in Table 1 considered a more detailed decision process to explain South Carolina fishermen's decisions based on the results of a questionnaire mailed to S. C. boat owners within 100 miles of the coast. Bockstael et al. [1986] assumed that each individual's decision was part of a nested process with the preferred fishing activity at each possible launch site described. Then a preferred launching site was determined based on the best fishing activity. The types of fishing were nonreef and artificial-reef. The determinants of these decisions included the expected catch of principal and secondary species, expected costs, years of experience fishing off the South Carolina Coast, and the expected percentage of trips in which fishermen expected to catch no fish. The expected-catch and cost variables were based on respondents' reports or "imputed" from similar fishing mode (troll or bottom) and boat sizes when these responses were missing.

The authors did not report sufficient information to gauge the statistical significance of their estimates but did report some comparative benefit estimates. Three launch areas were identified. The model implied that the value of a 20 percent improvement in the reef catch rate would range from $38 to $90 per user per year.

To develop the overall estimate of the value of an artificial reef as reported in Table 1, the authors developed a second stage launch site model based on the inclusive value from the first stage and the travel cost. The inclusive value is a gauge of the desirability of the reef/nonreef alternatives accessible from each launch area. Using this model, it is possible to capture the unconditional value of a reef by gauging how high the costs of reef use would have to be to cause the individual to stop selecting them. This is the $195 reported in the table.

Building on this pilot study, Milon [forthcoming] also has used a nested logit model to estimate the values for artificial fishing. Based on the registrations of boat owners in Dade County, Florida, Milon composed a stratified sample by zip code and conducted a mail survey of 3,600 individuals in 1985. The response rate was 45 percent, and 75 percent of those respondents (887) participated in saltwater fishing during the sample period. Trips were specified as a single fishing day in his model. Moreover, the launch point was treated as exogenous to the where-to-fish decision in terms of three types of site classifications - near shore, offshore natural habitat, and offshore artificial habitat. Thus an important distinction arises between this study and most other work which uses travel to a launch point as an important component of the travel costs. In other such studies, information on the locations and features of the areas in the sounds or the ocean used for fishing is not as detailed as in the Milon analysis. Because his analysis is primarily for local recreation with abundant access, Milon argues that the launch decision can be ignored. While this is probably correct for his case, the assumption bears directly on the site-definition issue we raised in Chapter 2. We will return to this issue in the next two chapters.

The choice process is described as involving three levels of decisions:

(a) conditional on sport fishing - select near shore or offshore;

(b) conditional on offshore, select type of habitat - natural or artificial;

and

(c) conditional on the outcomes of (a) and (b), select a specific location for fishing.

The site selection decision at level (c) was specified to be determined by travel cost and time (here referring to costs and time associated with boat travel), the site specific mean catch rate for all fish (e.g. kept plus released) expressed as weight per person-hour from recent experience, as well as the variability in that experience across individuals, and, for artificial sites, the age of the site. All variables were statistically significant and generally had plausible signs. The only potential coefficient that might be subject to question would be the variability measure for catch. The coefficient of variation had a positive effect on site choice.

The other stages in the decision process were specified to be determined primarily by variables describing equipment and knowledge. Two notable exceptions were age and income as determinants of the offshore/near-shore choice. Both are negatively related to the offshore choice. This seems a counter-intuitive finding for income.

The model was used to estimate per person per trip benefits from a new artificial site at different locations. As the last column indicates, the average value (across respondents) varied by site location from \$1.60 to \$1.80.

The Bockstael, McConnell and Strand [1988] random utility analysis of sport fishing in Florida is a preliminary analysis of their ongoing larger study based on additional interviews of fishermen contacted as part of the National Marine Fisheries Service (NMFS) intercept survey. It considers the completed interviews in the November to December 1987 wave of the NMFS survey intercepted in Florida. Their sample includes 158 respondents who provided information on 161 distinct day trips. Because of the relatively small sample, nine sites were composed from combinations of coastal counties, and fish species were aggregated into three groups.

A two-stage nested random utility model was specified to describe these recreation decisions. First, the mode/species choice is determined with six combinations: shore-small game, shore-no target, boat-big game, boat-small game, boat-bottom, and boat-no target. Then conditional on this choice, a site is selected. The site selection models varied with mode and type of fishing, including the travel cost (including vehicle costs and time costs valued at 80 percent of the wage rate for those who could vary their time and travel time separately for those who could not vary). Nontarget fishermen and big game fishing were assumed to base fishing quality on the success rate, while others used the catch rate. The effect of travel cost on site selection was assumed constant across mode/species choices, as were the effects of travel times, catch, and success rates. The mode/species decisions was specified to be determined by the inclusive value from the first stage and a qualitative variable for boat ownership. In general, the model appears to offer a good description of recreationists' decisions.

Two types of welfare calculations were developed. The first of these was the value of access to a site per choice occasion. These estimates ranged from $.73 to $6.81 for private boating and $.81 to $7.94 for all models. The average values were reported based on values calculated for all sample respondents.

Several quality changes were also considered based on changes in either the success rate or the catch rate. Again, averages were reported for all respondents without regard to their actual species/mode choice.

The last RUM study in the table, by Carson, Hanemann and Wegge [1987], is also the most detailed to date. The analysis is based on three separate surveys of resident anglers. A survey was sent in August about fishing trips taken during May through July and in the preceding winter. For respondents to this first survey, a survey was sent in October about fishing trips in August and September. A combination survey covering the whole summer season was sent to those who did not respond to the August survey. In addition, a survey of out-of-state recreationists was conducted. To identify the various resident samples, a preseason survey was used to identify individuals (residents) who intended to (or might) fish in Alaska between May and September. A survey was also sent to nonresident fishermen based on the nonresident angler license files for 1983-1985 and 1986.

Of the questionnaires delivered, 35.3 percent returned the August resident questionnaire, 64.7 percent of this group returned the follow-up version, and 29.9 percent of the nonrespondents to the August questionnaire returned the combination questionnaire. The nonresidents had higher rates for those in the United States in comparison with international locations and somewhat higher rates for the 1986 file of license holders.

Figure 3.1 is taken from Carson, Hanemann and Wegge [1987] and summarizes the nested decision process they assumed:

Step I decide to participate and number of trips in specific weeks of season;

Step II select a target species - salmon, freshwater, saltwater, or nonspecific;

Step III select subspecies type;

and

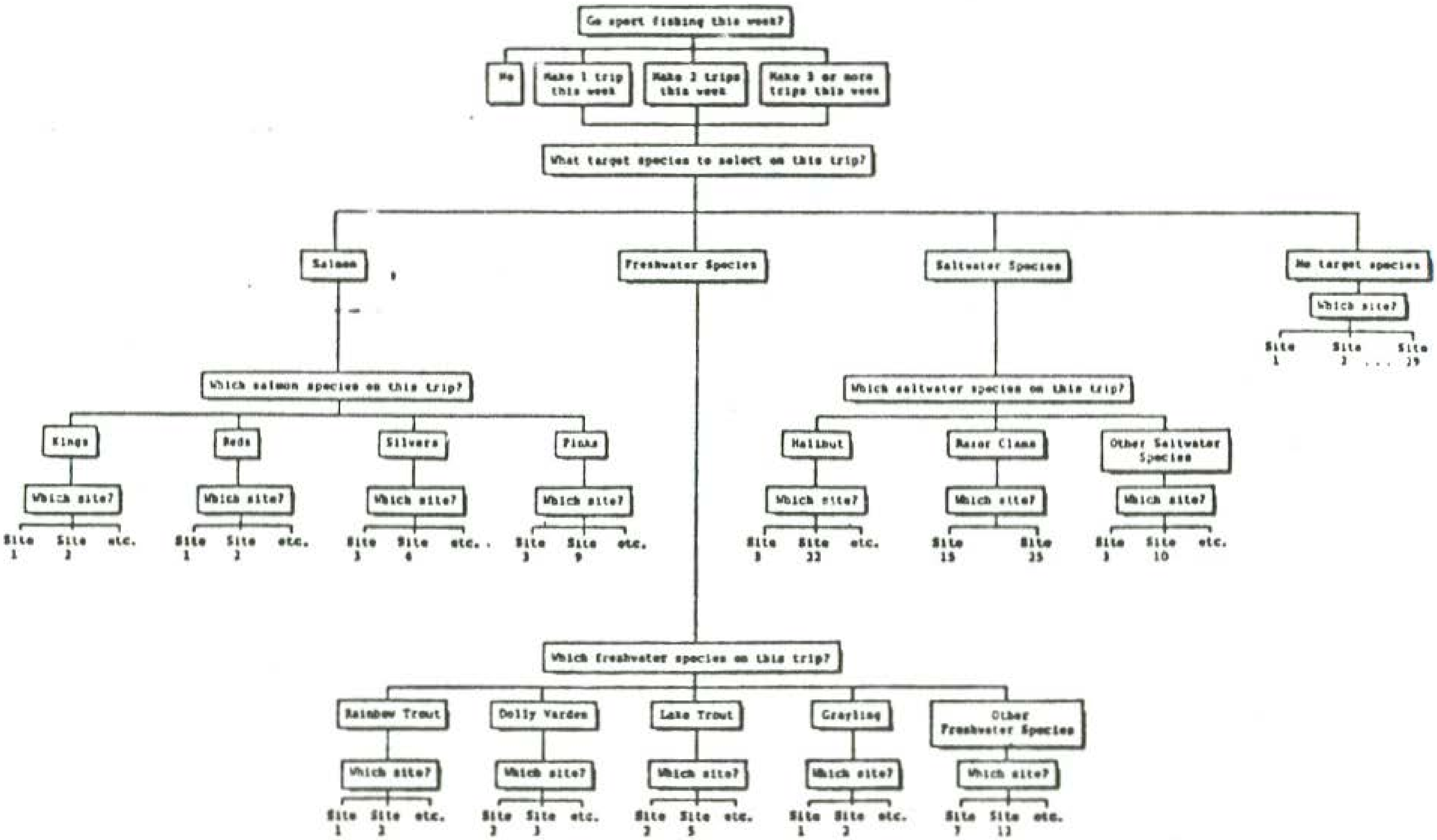
Step IV select a site.

Twenty-nine sites were identified, though not all sites were assumed to be relevant for all species. For our purposes, some of the most important variables in the study were associated with the quality of the site and their

FIGURE 3.1

DECISION TREE FOR ANALYZING RESIDENT ANGLER'S DEMAND FOR SPORT FISHING

Source: Carson, Hanemann and Wegge [1987]



relationship to measures of the availability of fish. The specific quantity variables included:

- a site rating based on a subjective weekly index normalized by the mean rating for the site over the season;
- a general index of quality of fishing (again qualitative) for salmon, freshwater, and saltwater groups at each site in the relevant week;
- the 1985 harvest of all species at the site.

The site selection equations by species supported the use of variables based on both the site rating and the 1985 harvest, with statistically significant and positive effects on the likelihood of selecting a site.

Estimates of net willingness-to-pay for the summer sport fishing trip and for winter trips were prepared under varying criteria, including variations in the site used and the origin for the recreationist. We report ranges for these estimates in 1986 dollars in Table 3.1. Unfortunately, there was not sufficient information to estimate the value implied by the model for quality changes.

The remaining estimates in the table are from contingent valuation (CV) surveys. Bell, Sorenson and Leeworth [1982] included a CV question as part of an analysis of the economic impact of saltwater fishing in Florida. Their CV question was posed as:

> Having thought about how much saltwater fishing in Florida cost you in the last 12 months, <u>how much more money</u> would you spend annually before decided to stop doing it because it was too expensive? (Bell et al. [1982], p. 72)

The average for all regions from Florida resident anglers was $743 as the annual willingness-to-pay. Nonresidents were willing to pay substantially less, an average of about $154.

These results are difficult to interpret and may reflect a strategic bias. Some indirect evidence for this conjecture is found in responses to another question. When asked if they would pay $6.75 annually for a fishing license, only about 57 percent of the in-state respondents would be willing to do so.[2] While this may reflect a response to the intended use of the funds for "fishery management," it does raise questions on the appropriate interpretation of the valuation responses.

The Thompson-Huppert [1987] contingent valuation was expressed in terms of specific changes in the catch rates for salmon and striped bass using both willingness-to-pay (WTP) and willingness-to-accept (WTA) valuation frameworks. Both positive and negative changes were considered with the willingness-to-pay used for improvements and for avoiding declines and the compensation required (WTA) for proposed declines. A payment card format along with an arbitrary upward adjustment in responses was selected in composing the averages in the tables.

Since these results are preliminary and further specific analysis of the survey results is underway, it is difficult to judge their plausibility at present. As we noted above, the WTP results are consistent with our derivation of the value of a 40 percent improvement in the catch rates for striped bass based on the Bockstael, McConnell, and Strand [1987] Tobit model for the Chesapeake.

The last contingent valuation study involves two studies by Cameron [1988a, 1988b] using various components of a large creel survey of Texas fishermen during the period of May to November 1987 along the full coastal area of Texas. While 10,000 responses were collected, the two analyses are based on subsets. The first of these focuses on complete and apparently consistent observations (based on preliminary criteria described in detail by Cameron

[1988a]). A discrete or closed-ended CV question was asked of each respondent as follows:

> If the total cost of all your saltwater fishing last year was _____ more, would you have quit fishing completely?

The value posed varied from $50 to $20,000 across respondents in a format that approximated a random assignment.[3]

This study (Cameron [1988a]) reported preliminary estimates of discrete choice models based on specifications for inverse demand models, as proposed in Cameron and James [1987]. All of the results were described as preliminary. Attempts were made to take account of water quality and species-specific catch rates estimated for the same locations of these interviews with different data sets.

The modeling structure hypothesizes that these responses should depend on the perceived quality of the sites involved. However, the preliminary results indicated several types of contradictory findings with attempts to describe quality with the very detailed (i.e. species-specific) catch rates, as well as water quality in terms of measures for the concentrations of specific pollutants.

The second study (Cameron [1988b]) focuses on a subset of these data for respondents who reported that they took 60 or less fishing trips during the season. This study is primarily a methodological innovation. It proposes that discrete contingent valuation responses can be combined with the actual trip-taking decisions so a single model describing past recreational choices would be used to estimate a common set of parameters.

Using a quadratic utility function and this restricted data set, Cameron [1988b] developed several different estimates. However, none of these models attempted to incorporate any of the quality variables distinguishing the features of different locations along the coast.

The valuation figures reported in Table 3.1 correspond to estimates of an individual's willingness to pay for access (based on the quadratic utility specification expressed in terms of fishing and "net" income as a proxy for all other goods). Based on the structure of the model, this should probably be interpreted as an annual payment to avoid a complete loss of access to all sites. A variety of other definitions were considered to describe situations with partial loss of access and corresponding willingness-to-pay estimates. We report here one calculation based on the model and not separate questions of respondents for a 10 percent loss in access.

In our judgment this effort offers a promising methodological advance, but does not offer benefit estimates that are useful for policy. All sites are treated as equivalent. The situation used for benefit estimation simply derived the maximum one-time fees to reduce all trips to zero or to cut trips by some percentage, provided past decisions and responses to the discrete CV questions could be explained using the same basic model.

Overall this selected summary indicates considerable progress with RUM models, but little information that would fit the situation arising in the Albemarle-Pamlico area where the models must be capable of estimating the recreation benefits from quality changes. Moreover, a comparison of the two most detailed models by Carson, Hanemann and Wegge [1987] and Milon [forthcoming] suggests that local conditions are quite important to the structure of recreational decisions.

3.3 The Walsh et al. Benefit Estimates for Saltwater Fishing

Table 3.2 is taken from the Walsh et al. [1988] overview. The citations for the studies they consider indicate that their review and ours overlap considerably. This study is an update of an earlier effort by Sorg and Loomis [1984] covering studies between 1968 and 1982. Both efforts seek to provide constant dollar per activity day estimates of the typical individual's values for specific types of recreational experiences. The focus is on valuing the activity and not the site. This qualification can be important to sites that support multiple activities simultaneously. For the most part, the Walsh et al. analysis assumes this is not the case. Their methods assume individuals engage in only one activity when visiting a specific site. They also generally use the travel cost (including the time costs of travel) as the implicit price of the activity. Strictly speaking this is not correct, but its importance will depend on the quantitative importances of equipment and other recreation-related inputs, in addition to the site and a person's time for the activities involved. In the case of marine recreational fishing these could be quite important considerations and should be considered in interpreting what are essentially standardized values for site services as values for the activities.

The adjustments used to standardize the estimates across studies followed Sorg and Loomis. They were:

- travel cost-based estimates of value were increased by 30 percent for the omission of travel time;
- travel cost and contingent valuation estimates were both increased by 15 percent for the omission of out-of-state users;
- travel cost-based estimates were decreased by 15 percent when individual observations were used;

and finally

TABLE 3.2
Salt Water Fishing Literature Review and Benefit Estimate, 1987

Author Study Location Date of Survey Method	Value per Activity Day		
	Reported	Adjusted to 1987	Adjusted for Method
Carson, Hanemann & Wegge [1987] Alaska 1986 TCM Salmon, Halibut	149.25-213.35	153.73-219.65	153.73-219.65
Cameron & James [1987] British Columbia 1984 CVM Salmon	48.83	53.37	53.37
Rowe et al. [1985] California, Oregon, Washington 1981 TCM General	56.80	71.23	60.55
Huppert & Thompson [1984] California 1979-80 TCM Party Boats	13.00-20.00	18.69-28.76	18.69-28.76
SMS Research [1983] Hawaii 1983 CVM General	47.00	53.35	53.35
Brown et al. [1980] Oregon 1977 TCM Salmon	78.00	136.66	136.66
Brown et al. [1980] Washington 1977 TCM Salmon	75.00	131.40	131.40
McConnell [1979] Rhode Island 1978 TCM Flounder	30.34-67.06	49.55-109.51	42.12-93.08

TABLE 3.2 (continued)

Author Study Location Date of Survey Method	Value per Activity Day		
	Reported	Adjusted to 1987	Adjusted for Method
Crutchfield & Schelle [1979] Washington 1978 CVM Salmon	18.00	29.39	29.39
Charbonneau & Hay [1978] U. S. 1975 CVM Surf	73.00	145.12	101.58
Charbonneau & Hay [1978] U. S. 1975 CVM Surf	19.00	37.77	26.44
Charbonneau & Hay [1978] U. S. 1975 CVM Bays	22.00	43.74	30.62
Charbonneau & Hay [1978] U. S. 1975 CVM Pier	16.00	31.81	22.27
Charbonneau & Hay [1978] U. S. 1975 CVM General	22.00	43.74	30.62
Average Total Value	51.58	76.25	68.50
1983-88 (5)	70.08	77.67	75.34
1968-1982 (9)	41.30	75.46	64.69

SOURCE: Walsh et al. [1988]. Their report and the full citations to all studies are in the reference to this paper.

- all were put in 1987 dollars using the GNP implicit price deflator on the price index.

Omitting the adjustments for all factors but inflation, the per day values range from approximately $20 to $220. The highest of these is from the Carson, Hanemann and Wegge [1[987] RUM model based on travel cost data.

These results are useful as a potential set of bench-marks for interpreting our own results. Of course, expressed in these general terms, they do not

offer insight into the value of the quality changes (e.g. improvements in catch rates) that might accompany management of estuarine resources.

3.3 <u>Summary</u>

This chapter has provided a selective summary of the available empirical literature on the value of marine recreational fishing from two perspectives. The first considered what is known about the value of changes in fishing quality. The second summarized another effort to distill values for activity days involved in marine recreational fishing.

The result of these efforts is a clear perception that the literature is changing rapidly in this area. While the range of uncertainty is large, it is narrowing as a result of these efforts. Local conditions are important sources of these differences, so transfer of estimates prepared for one location to the Albemarle-Pamlico Sounds would be undesirable. Finally, the knowledge of the values for quality changes are especially limited.

Chapter 3

FOOTNOTES

1. Nonusers were assigned the expected levels, so the evaluation considered only the treatment of these variables for users.

2. Similar findings were observed with nonresidents. Only 52 percent of the tourist anglers in Florida stated they would be willing to purchase a license of $10.50, despite their high stated WTP for the activity.

3. The full set of values used in this question were: $50, $100, $200, $400, $600, $800, $1,000, $2,500, $5,000, $20,000.

Chapter 4

The Albemarle-Pamlico Estuary and the N. C. Sea Grant Recreational Survey

4.1 Introduction

The purpose of this chapter is to provide some general information on the Albemarle and Pamlico Sounds and to describe the data base developed for this study. The focus of this description is on the features of the estuary that support marine recreational fishing. The primary source of our information on the uses of the area is an intercept survey conducted during the summer seasons of 1981 and 1982 and sponsored by the North Carolina Sea Grant Program (see Johnson et al. [1986]). While the original survey included some 1,012 interviews, our analysis was limited to 723 interviews of boat fishing parties where it was possible to identify the launch point used to enter the area. Because the Johnson et al. report provides a detailed description of the survey procedures and extensive tabular summaries of the responses, we have limited our discussion in section 4.3 to an overview of the highlights of the survey procedures and attributes of the data.

This data set was augmented in several important ways to provide detailed information on each respondent's access to all the identified launch points (where interviews took place), as well as measures of the characteristics of these areas, including the average fishing experiences of other fishermen using each launch point, measures of effluent discharges in proximity to each location, and economic estimates characterizing the opportunity costs of each respondent's time. The specific details of these calculations have been developed in individual appendices to this report.

Section two of this chapter describes some of the characteristics of the estuary and the recreational and commercial fishing activities supported by it. In the third section we describe the intercept survey data and provide an overview of the reasons for augmenting the data base, as well as the logic underlying the specific procedures used in developing the variables used in our analysis. The last section summarizes the chapter and discusses the prospects for using the data base in other applications.

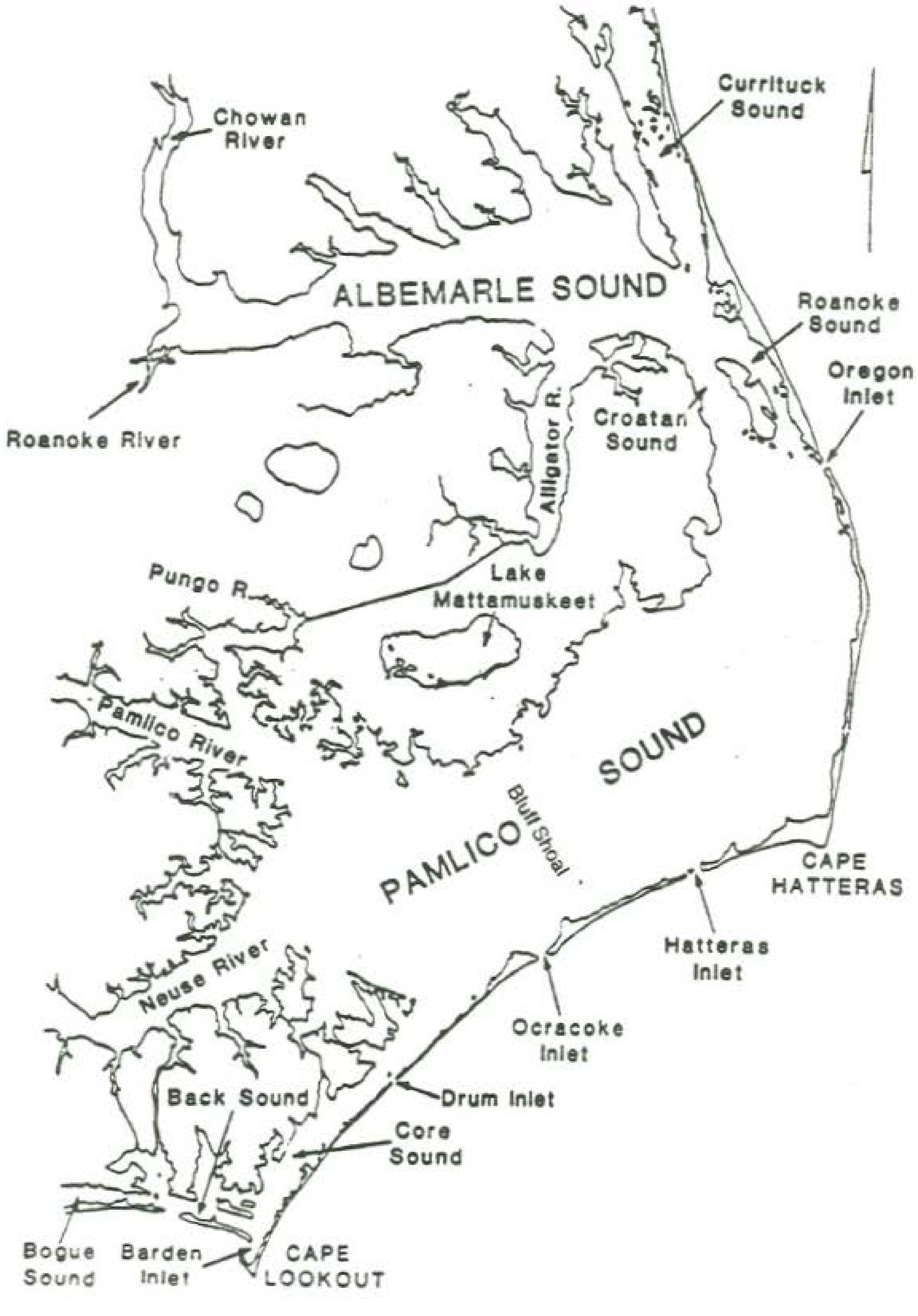
4.2 <u>Characteristics of the Albemarle and Pamlico Sounds</u>

Figure 4.1 taken from Epperly and Ross [1986] provides a schematic overview of the two sounds and key landmarks in the area. The Albemarle Sound covers approximately 480 square miles, while the Pamlico is approximately four times larger with over 2,000 square miles. Both sounds are shallow with a maximum depth of 26 feet near Pamlico Point. They are separated from the Atlantic Ocean by a chain of barrier islands.

The Albemarle Sound has very low salt concentrations in the water and is designated as an oligohaline estuary. The far western portion of the Sound is approximately freshwater because it is primarily influenced by the rivers flowing into the Sound.

In contrast, the Pamlico Sound has a higher salinity level and is classified as mesohaline in some areas (5-18ppt) and polyhaline in others (18-30ppt). Overall it has a fluctuating salinity level. Table 4.1 summarizes some general information from the National Estuarine Atlas being developed by the Strategic Assessment Branch of NOAA's Office of Oceanography and Marine Assessment. Flow rates in the two sounds are highest in the winter and decline in summer months.

FIGURE 4.1



Source: Epperly and Ross [1986]

TABLE 4.1

Characteristics of the Albemarle and Pamlico Sounds

Sound	Albemarle Sound	Pamlico Sound	Pamlico and Pungo Rivers	Neuse River
Estuarine Zones (miles^2)				
Tidal Fresh	726	96	41	25
Mixing	196	1891	125	148
Seawater	0	40	0	0
Total	922[a]	2027	166	173
Flow Rates (1000 cfs) (long-term daily average)				
January	30.2	23.4	5.1	9.0
February	33.6	22.5	5.6	11.2
March	32.6	27.1	6.0	11.9
April	27.8	21.9	5.6	8.0
May	25.9	20.6	6.4	4.6
June	22.1	21.6	5.9	4.1
Dimensions (miles)				
Length	107	120	42.0	50.0
Width (average)	10.5	15.7	3.5	4.1
Depth (average)	19.0	18.0	12.1	12.3

Source: Draft of National Estuarine Atlas, Strategic Assessment Branch, Ocean Assessments Division, NOAA

[a]The NOAA definition includes a wider area that considers Currituck Sound and the river outlets into the Sound as components of the estuary. This accounts for the discrepancy between the text and this table.

Because of its low salt levels, the Albemarle supports important fish nurseries for anadromous species. The adult members of these species use upstream tributaries of the Sound to spawn, and then developing juveniles use the western portion of the Sound as a nursery area. The western fringe of the Pamlico Sound and the Neuse, Pamlico, and Pungo Rivers, are good habitats for quasi-catadromous species, including spot and croaker. These are generally either cold weather spawners or offshore spawners. Some species such as grey trout are warm water spawners, using the Sound or nearshore waters.

Of the two sounds, the Albemarle has experienced greater levels of contamination arising from nonpoint source pollutants. Table 4.2 provides a partial summary of the water quality and use comparisons developed by Desvousges et al. [1986] approximately two years ago. Both sounds support commercial and recreational fishing and other recreational activities. There are more public access points to the Pamlico Sound.

Tables 4.3 and 4.4 provide a detailed description of the landings of the primary commercial species for the Albemarle and Pamlico Sounds from 1972 to 1986. For both sounds yields have declined for nearly all species from their historic highs in the late 1970's or early 1980's. The only important exceptions to this pattern are blue crab for the Albemarle Sound area and shrimp (with unstable landings in recent years), hard clams, and oysters for the Pamlico.

It is difficult to use these statistics to gauge any changes in the quality of either sound. They reflect both the quality of fishing opportunities and the effort devoted to fishing. Nonetheless, they do indicate that both sounds can, in principle, support active fisheries with opportunities for recreational and commercial fishing. As Table 4.2 indicates, the area also

Table 4.2

Water Quality and Use Comparisons: Albemarle and Pamlico Sounds

	Albemarle Sound	Pamlico Sound
Water Quality		
Salinity Level	Oligohaline (0-5 parts per thousand [ppt])	Mesohaline (5-18 ppt) Polyhaline (18-30 ppt)
Oxygen Saturation	60 percent (average)	50 to 60 percent (average)
Source of Pollutants	Nonpoint Limited industry on tributaries	Nonpoint Limited industry on tributaries
Pollutants	Nitrogen and phosphorus	Nitrogen and phosphorus Phosphate mining
Water Quality Problems	Algae blooms Red sore disease	Fluctuating salinity levels, algae blooms, red sore disease, ulcerative mycosis in tributaries
Uses and Activities		
Adjacent Land Use	Agriculture Forestry	Agriculture Limited forestry
Water Use	Water supply in Virginia Pulp and paper industry	Water supply Pulp mill on Neuse River Some Industrial Use Navigation Channel
Recreational Activities	Fishing, boating, hunting, swimming	Fishing, boating, swimming, hunting
Recreational Access	Private; some public access points	Public and private
Unique Recreation Areas	Great Dismal Swamp Alligator Rim National Wildlife Refuge	National Wildlife Refuges: Cedar Island Swanquarter Croatan National Forest
Countervailing Influences on Recreation	Limited access due to shoreline	Limited access due to shoreline
Alternative Recreation Sites	Currituck Sound Outer Banks	Outer Banks Bogue Sound

Source: Desvousges et al. [1986]

TABLE 4.3

Landings of principal commercial species from the Albemarle Sound area, North Carolina, 1972-1986 (in thousands of pounds)

	SPECIES													
	River herring	Blue-fish	Catfish	Croaker	Flounder	Weakfish	American shad	Spot	Striped bass	White perch	Shrimp	Blue crab	Hard clam	Oysters
1972	11,237	22	2,353	19	121	26	130	23	314	190	0	1,499	0	0
1973	7,925	6	1,875	29	73	10	81	19	535	139	0	1,647	0	4
1974	6,205	27	1,738	282	102	36	117	39	449	281	44	1,863	0	8
1975	5,949	26	1,633	293	232	51	87	18	636	272	0	1,439	0	1
1976	6,401	73	1,481	442	215	78	78	11	676	178	0	922	0	3
1977	8,520	15	2,047	246	11	41	80	19	470	258	0	1,051	0	18
1978	6,570	4	1,688	145	22	41	159	21	525	483	3	2,796	0	6
1979	5,031	89	1,496	1,062	43	246	85	143	327	321	0	2,708	0	44
1980	6,179	45	1,403	802	26	137	69	129	377	82	30	1,959	0	13
1981	4,560	37	1,672	165	59	40	67	33	333	348	5	3,905	0	14
1982	9,408	63	1,165	894	62	99	119	232	228	634	15	6,264	0	25
1983	5,859	38	1,014	380	201	74	216	48	289	452	10	6,375	16	32
1984	6,493	64	1,284	533	129	124	227	61	476	417	4	2,813	21	49
1985	11,537	40	1,238	353	121	52	149	39	270	679	98	5,446	12	10
1986	6,767	12	1,136	487	281	40	120	42	173	652	0	8,073	0	5

TABLE 4.4

Landings of principal commercial species from the Pamlico Sound area, North Carolina, 1972-1986 (in thousands of pounds).

	SPECIES														
	River herring	Blue-fish	Catfish	Croaker	Flounder	Weakfish	American shad	Spot	Striped bass	White perch	Shrimp	Blue crab	Hard clam	Oysters
1972	0	50	22	273	265	144	267	218	155	11	2,073	9,418	0	215
1973	<1	122	13	1,257	322	388	205	719	106	6	1,744	8,393	0	348
1974	5	325	16	2,324	715	510	226	648	62	28	3,162	8,682	0	328
1975	<1	553	21	5,489	992	1,349	131	1,724	80	17	1,558	7,597	0	248
1976	0	417	19	5,377	1,019	1,455	80	1,085	28	6	3,197	8,599	0	168
1977	3	645	21	6,788	393	2,481	23	1,458	10	10	3,442	9,634	0	199
1978	36	373	46	7,444	866	2,840	198	1,875	7	16	840	15,651	1	113
1979	0	0	16	9,612	824	2,847	112	3,108	39	40	920	19,365	2	261
1980	38	814	44	11,302	2,275	4,793	64	3,275	56	23	4,378	27,970	0	382
1981	51	590	44	7,570	1,453	2,934	123	1,676	25	47	847	29,230	2	245
1982	20	822	25	6,729	1,243	2,263	146	3,153	16	31	2,701	26,677	3	266
1983	9	401	36	4,951	1,527	1,670	158	957	17	46	1,934	24,571	7	409
1984	12	571	46	3,799	1,108	2,058	264	1,514	21	23	763	25,862	2	465
1985	11	762	41	3,655	1,282	1,707	150	1,444	10	22	8,168	20,307	38	334
1986	7	613	45	3,238	1,582	1,627	138	1,321	16	20	3,107	13,599	26	455

supports other activities that would be affected by environmental quality. We have not discussed these in detail because the focus of our analysis is on recreational fishing.

The Albemarle-Pamlico Estuary is an important resource. The reauthorization of the Clean Water Act specifically identified the area as an estuarine resource with national significance. This brief overview of the features of the two sounds indicates that a wide range of activities are supported by the estuary and that many of these are adversely affected by nonpoint source pollution entering the area through the multiple rivers that contribute fresh water to both sounds.

Quantification of these effects requires documentation of the full intervening mechanism connecting the activities that cause the nonpoint source pollution to the quality features of the estuary important to the activities it supports. Unfortunately, no systematic process has been established to collect the information necessary to understand this mechanism.

While many economic activities rely on having access to a variety of different types of services provided by the estuary, these services are available largely outside markets. Commercial and recreational fishing have relatively free access to both sounds. Fishing activities are regulated only periodically, usually in reaction to some damage to the estuary or to fish populations supported by it.

The absence of markets for these services means we must rely on indirect methods for inferring the contribution of the estuary to economic activities. As we noted in the introduction and described more fully in Chapter 2, the travel cost recreational demand model is one such method. To implement it requires detailed information on the recreational decisions of a sample of individuals using the area. These types of surveys are difficult and costly to obtain. Indeed, while the North Carolina Division of Marine Fisheries in cooperation with the National Marine Fisheries Service periodically undertakes a creel survey of fishermen using the area, the information collected is not sufficient to estimate detailed demand models for recreational fishing in the area.

Fortunately, a detailed survey was undertaken for the area by the North Carolina Sea Grant Program during the 1981 and 1982 seasons. These data provide the basis for our analysis and are described in more detail in the next section. It is important to note that without this survey our analysis would not have been possible. Moreover, given the six years between the date of the survey and the initiation of this research, it is also important to recognize the need to continue to acquire such data on a more systematic basis. We expect that recreational uses of the area have increased and that the patterns of use may have changed. Until we repeat a survey comparable in detail to the Sea Grant effort, it will be impossible to evaluate how these changes affect the demand and valuation estimates derived from our analysis.

4.3 The N. C. Sea Grant Survey

The North Carolina Sea Grant survey was undertaken in 1981 and 1982 to collect information on recreational fishing in the upper sounds of North Carolina. Johnson et al. [1986] indicate that these data were collected to serve three objectives:

(1) to understand the socioeconomic characteristics of marine recreational fishermen in the region;

(2) to enhance knowledge of the social organization and cultural values of participants in recreational fishing in the area;

and

(3) to provide information on the economic demand for and impact of recreational fishing in the area.

The survey extended from early May 1981 to mid-November of that year and from mid-April 1982 to the end of October 1982.

Because of the large number of access points to the area, the sampling procedure required that interviewing recognize the different levels of fishing pressure in different areas of the two sounds. Johnson et al. [1986] describe the process as one that began with a set of sites identified from the 1981 North Carolina Fishing Guide. Fishing pressure was defined as the number of fishing parties originating from each location. Three sources were used to gauge the pressure from each site, including the area law enforcement supervisors of the Division of Marine Fisheries of the N. C. Department of Natural Resources and Community Development, marina owners and operators, and on-site observations.

Index values were constructed for each site based on levels of effort in comparison to total effort for all locations. Interviewers were randomly assigned with greater sampling at access points with a higher percentage of effort. Seventy percent of the sampling took place on weekends and thirty percent on weekdays.

Table 4.5 identifies the number of respondents in our sample who were classified as boat versus bank fishing for each year. In 1981 four to six added interview days were randomly selected for collecting information on recreational bank fishing in each month. The bank access points were assigned in a nonrandom fashion to select specific bridges or areas of shoreline. This practice was not continued in 1982. Because our objective was to model

TABLE 4.5

Total Number of Observations in Each Sample

	1981	1982	Total
Bank Fishing	209	77	286
Boat Fishing	391	332	723
Other	2	1	3
Total	602	410	1,012

recreation site demands at the lowest level of aggregation, we sought to maintain the sample of recreationists at each entry point as large as possible. Therefore, we pooled responses across the two years.

Figure 4.2 displays a portion of a map for North Carolina with each of the interview sites marked on the map. This map was not part of the original information from the survey and had to be reconstructed based on a detailed review of survey materials, various issues of the North Carolina Fishing Guide and extensive discussions with Dr. Jeffrey Johnson.

Because the primary use of the survey to date has been as a source of descriptive information, considerable effort was required to develop the data base that meets the requirements for detailed economic modeling.[1] As Chapter 2 described, the travel cost model requires three types of information: the amount of use an individual makes of the recreation site being modeled, the degree of accessibility of that site and the available alternatives, and the costs of using the site. In the absence of entry fees, these costs are primarily the travel costs to get to the site and the opportunity costs of the time spent traveling to the site.

Unfortunately, the survey did not have ideal information for any of these variables. Because the survey was a site-intercept survey, we know the site each fisherman used for the trip when they were interviewed. However, neither the level of usage nor the access measures acquired in the interview conform to what we would have liked. Conventional practice uses the number of trips to a site as a measure of the quantity demanded of the site's services. When possible we attempt to use trips that are of the same length and that take place during times that are approximately comparable (in terms of constraints on the individual's time).

FIGURE 4.2

Albemarle-Pamlico Estuary with Site Locations

SOURCE: Kaoru [1989]

The survey provided information on the interview trip, but very little information on other fishing trips. Indeed, this limitation is quite important to the application of the travel cost model with these data. More specifically, we have assumed that respondents' answers to a question requesting the number of times they fished last year refers to marine fishing at the site where they were interviewed. This is not what the question asked. However, it was asked in the context of requesting information about the current trip and other aspects of the individual's sport fishing. Thus, the prospect for measurement error clearly exists in both use measures. Individuals could have reported trips to all sites and very likely were subject to recall error. These considerations, along with other assumptions of the travel cost model, have led us to initiate the process of developing and applying other models to a subset of the information in this survey. These other models focus on the single trip when a respondent was interviewed and ignore this other information. In subsequent research, we plan to compare the models developed here with those using the more limited information but not requiring these assumptions.

No other information was requested of respondents on the characteristics of these other trips. While we do have information on the days spent fishing during the trip of the interview, we do not know how this compares with other trips. As a result, it is impossible to standardize for either trip length (i.e. days on site) or the potential for other constraints on the time used for these trips. This quantity measure is the most serious limitation to our analysis and very likely offers the greatest potential source for error.[2]

The survey did ask distance traveled from home to the site but not to other potential sites for using the sounds. Equally important, these reported distances were quite variable for respondents from the same origin counties, larger than would be expected based on county size. To develop information on potential substitutes and provide an alternative measure of access to the site used, we measured road mileage from each origin county to each of the interview sites in the survey. Appendix 2 describes the specific procedures used.

These measurements were then assigned to each respondent from the relevant county. This assignment has two important implications. First, we have developed an alternative measure of the distance to the site for each respondent. Second, the distances to all other alternatives provide the basis for characterizing the relative accessibility of the available alternative sites.

To construct estimates of the travel costs for the site used and the alternatives, we scaled the round-trip mileage by estimating the travel cost per mile (20 cents). This figure is at the high end of the range of possible estimates. We also considered a midrange estimate of 12 cents. This had little effect on our results. We have used the higher estimate because we have not accounted for the costs associated with trailering boats. While not all of the boat fishermen own their boats, a large fraction (80 percent) do. Twenty cents per mile is more likely to provide a midrange estimate when these costs are also considered. Appendix 4 provides more information on the motor vehicle operating cost estimates.

The most important quantitative factor in determining the travel cost of a trip is the opportunity cost of the time involved. To calculate these costs, we assumed individuals traveled at 40 miles per hour and used two approaches to estimate wage rates for each respondent. The first of these used a hedonic wage model to estimate the wage rate for each respondent. These wage estimates were based on the reported occupations and socioeconomic characteristics of each respondent. The second procedure used the reported income divided by 2040, the typical number of working hours in a year. For this method, it must be assumed that all income is from wages. Appendix 1 describes the specific details for the first procedure and compares the results from both methods.

Because there are limitations with both methods, we developed our estimates with both approaches. Based on this analysis, our preferred estimates are based on the hedonic wage model.[3]

This information would be sufficient to estimate a travel cost demand model. Taken together with the fairly detailed socioeconomic information collected from respondents, it provides a data base comparable to the best available in the earlier marine recreation studies for other areas.[4] However, it is not enough information to evaluate the role of estuarine quality for these decisions. Two measures of quality were added to the data base. One of these uses the survey to estimate site-specific catch rates. A second used data provided by the National Oceanic and Atmospheric Administration (NOAA) estimating residuals generated in the relevant coastal counties for the sounds and the reports from major point sources along the sounds as indexes of the estuarine quality adjoining the entry points to the sounds. Appendixes 3 and 6 describe the procedures used in each case.

Table 4.6 and 4.7 provide some descriptive information on the survey respondents. They classify respondents by mode of fishing--boat and bank--for the full sample as well as for the subsamples composed for each of the entry point groupings we discuss in more detail in the next chapter.

TABLE 4.6

Sample Means: Whole Sample[a]

	Bank	(N)	Boat	(N)
Age	39.95	283	43.06	715
Party Size	2.65	286	2.80	723
Travel Cost	172.75	203	130.02	632
Trips	43.89	263	35.17	652
Total Expenditure	122.61	274	115.19	667
Fish Caught	9.54	258	34.85	590
Distance Traveled	202.64	203	137.02	633
Boat Ownership	.01	284	.84	713

[a]N designates the number of complete observations for each variable.

TABLE 4.7

Mean Values for Selected Variables for Boat Fishing Respondents by Composite Sites[a]

	Composite Site					
	Outer Banks		Pamlico		Albemarle	
Variable	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size
Age	43.90	352	43.81	159	41.55	162
Party Size	3.16	354	2.64	162	2.37	165
Travel Cost	193.16	330	83.56	138	40.74	157
Trips	30.68	315	36.46	149	36.49	148
Total Expenditure	217.88	311	34.17	155	20.10	159
Fish Caught	34.05	251	34.17	155	41.70	147
Distance Traveled	203.40	330	33.50	150	43.64	158
Boat Ownership	.81	348	.88	138	.88	163

[a]A Composite site is a collection of entry points into areas of the Albemarle-Pamlico Sounds. The specific definitions in terms of the entry points identified in Figure 4.2 are:

Outer Banks = 502, 504, 506, 601, 604, 605, 607, 608, 612, 619, 620

Pamlico = 614, 615, 616, 618, 701, 701, 703, 713, 716, 717, 802, 803, 804, 805

Albemarle = 301, 302, 303, 304, 305, 308, 310, 311, 402, 403, 404, 408

4.4 Summary

A significant by-product of this research has been the development of a detailed data base on the recreational behavior of individuals using this area. By constructing a clean SAS (SAS Institute [1985]) data file from the original survey and including information on other recreational alternatives, as well as measures of estuarine quality, we have developed a more extensive data base that can be used as a basis for a wide range of economic modeling of how recreationists use these sounds. Such future research can extend the types of policy questions considered in managing the estuary.

Our focus to date has been on boat fishermen and their reported fishing trips for the years preceding the survey. However, in the current format the data now will allow other types of recreation models to be developed.

Chapter 4

FOOTNOTES

1. Unfortunately, the "cleaned" version of the original survey was lost in the reorganization of the computer facilities at East Carolina University. This loss implied that the data file had to be reconstructed, eliminating observations associated with an unreliable interviewer and correcting a wide range of miscodings. This effort was not anticipated when the research was initiated and delayed the process of investigating demand models with the survey by several months.

2. We will discuss alternative models that can be implemented using only the data on the visit during which the interview took place in our description of future research in Chapter 7 of the report.

3. We also considered methods that used a fraction of the wage and allocated other costs of the trip based on the composition of the party and the days spent fishing as an approximate guide for all trips. Because the party composition and time allocation between fishing and other activities relate to the trip of the interview, there is no reason to believe that they will be consistent for all trips. Our results for these cost allocations are summarized in the Appendix to Chapter 5. They generally indicate that models based on the hedonic wage model without cost allocation are preferred, based on the stability of the estimates and their consistency with a priori theory.

4. Our required interpretation of the quantity measure is an important qualification to this judgment.

Chapter 5

The Demand for Marine Recreational Fishing in the Albemarle-Pamlico Estuary

5.1 Introduction

The purpose of this chapter is to report estimates of the demands of marine recreational fishermen for the services of sites within the Albemarle-Pamlico Estuary. More specifically, the analysis focuses on boat fishermen using sites within the sounds. Our models were developed in conformity with the professional consensus on the estimating of travel cost recreation demand models and explicitly recognize three of the most important influences to past studies:

(1) our measure of the implicit price of a trip includes both the vehicle related costs of travel and estimates of the opportunity costs of travel time;

(2) our demand specifications include aggregate price indexes developed for substitute sites within the sounds; and

(3) the estimators used for each model include both ordinary least squares and a maximum likelihood estimator with specific adjustment for the truncation resulting from an intercept survey of recreationists using the area.

Nonetheless, as we acknowledged in Chapter 4, a number of limitations in the data available for our analysis prevent us from considering other potentially important influences to these recreational decisions. We discuss the implications of these data deficiencies in the summary to this chapter.

Overall, the results are quite promising from two respects. First, the analysis has identified several conceptual issues that were not treated in the analyses of travel cost demand models and are likely to be important for using this framework to describe the demand for marine recreational fishing sites. Second, our empirical results have successfully estimated the demands for two composite sites in the estuary, and in the process estimated a role for fishing quality, measured by the average catch rate, for these demands. This aspect of our results is somewhat unique among travel cost models. As the review in Chapter 3 suggested, few conventional travel cost models have been able to estimate a role for site quality measures. This has been especially true for travel cost demand models involving marine fishing sites.

Section two begins the chapter by considering the conceptual issues associated with developing our specification of the demand functions. The first of these involves the definition of the recreation site that is relevant for marine fishing. As we acknowledged in Chapter 3, this issue is especially important when comparing the results of Morey, Rowe and Shaw [1988] and Milon [forthcoming]. The former defined a site by the launch point, whereas the latter ignored launch point (treating it as exogenous to the key issues in fishing decisions) and focused on the location in the ocean for fishing as the site. In principle, both aspects of the location decisions for fishing are important.

Because of the relatively poor performance of conventional travel cost models in isolating a role for quality measures for recreation sites in their estimates, we also consider a few theoretical approaches for describing how quality might influence demand.

Following this discussion, in section three we describe the specifications used for our demand models and the results for our three composite site aggregates - Outer Banks, Pamlico, and Albemarle. In the first two cases, we have developed reasonably good models that are quite robust to variations in their specifications with respect to what might be regarded as nonessential variables (from the perspective of economic theory) as well as to the estimator used. Our analysis of the demands by recreationists using the Albemarle sites was largely unsuccessful.

This section concludes with a brief discussion of the price and income elasticity estimates implied by these demand models, considering especially the variations in price elasticity with site quality.

5.2 Conceptual Issues in Modeling Demand: Site Definition and the Treatment of Quality

Most of the early applications of the travel cost methodology have had a clearly defined recreation site that was the destination for recreationists. Usually this was a park, lake, wilderness area or section of a river with a limited number of access points.[1] This issue becomes especially important for the case of marine recreational fishing because travel for boat fishermen can be divided into two components - travel to the launch point (or location where a charter trip originates) and travel by boat in the sounds to fishing locations. The launch point simply designates the approach a recreationist has used to gain access to the resource. In the case of the Albemarle and Pamlico Sounds this resource covers a wide area. Moreover, as described in Chapter 4, they encompass a wide range of ecological systems with varied fish stocks, vegetation, and salinity among other characteristics. In addition, the nature of the surrounding land also varies considerably from the recreation-oriented barrier islands of the Outer Banks (which are somewhat less accessible by land) to the forested mainland. Because of this diversity, the definition of a recreation site is more complex than for most other types of recreation.

Our study focuses on boat fishing, so the fishermen must make a series of decisions about the trip. The most important decisions concern the launch site and the particular area to be fished, although several other decisions such as target species may also be significant.

Several possible site definitions were available for this study, some of which have been used previously. At one extreme, it can be assumed that the launch site or entry point has no particular significance except to minimize the cost of getting to the water. This formulation corresponds to the implicit assumption of Milon's [forthcoming] study. In his case, the wide availability of entry points to the ocean in Dade County implies that differences in access to them across individuals is probably quite small. The most important consideration is travel by boat to a fishing location. In such a model, regardless of the entry point, fishermen are going to one of a few fishing areas. In our analysis, the most aggregate form of this assumption would treat all boat trips in the Albemarle and Pamlico Sounds as utilizing the same site. Of course, it would also be possible to disaggregate slightly by treating the two Sounds as separate sites. At the other extreme, one could assume that the chosen launch site was an important decision that influenced the entire trip. Each entry point would then represent a separate site, and travel cost models could be developed separately for each site if an adequate number of observations were available at each site.

There are practical limitations to our ability to evaluate these definitions using the conventional travel cost demand framework. At the simplest level we must have a sufficient sample of respondents as well as variation in their patterns of use, costs, and socioeconomic characteristics to attempt to "explain" their respective demands for each site's services. Table 5.1 lists the number of observations for boat fishermen by coastal county and launch point (identified in Figure 4.2 in chapter four) within those counties. It is clear even at this level that the survey imposes limits on what can be considered.

Of course, there is a more important consideration in evaluating the alternative definitions for a site than simply what the survey will permit. This relates to what we are trying to describe. Our analysis is intended to model the demand for the services of the recreation site. Therefore, it is reasonable to expect several launch points will be providing access to the same basic resource.[2]

Our analysis has adopted a compromise strategy, using the geography of the area, together with information obtained from fishermen and those familiar with the area to define three sites.[3] Each site is a group of launch points for entering the sounds. They are defined to correspond to broad geographic areas with differing salinity levels and types of fish species available, provided the entry point is an adequate indicator of the general area for fishing.

Because of the significantly different characteristics of Albemarle Sound and Pamlico Sound, the demand models treated trips that launched from the mainland in the two Sounds differently. Thus, these correspond to our first

TABLE 5.1

Sample Distribution for Boat Fishermen
by Coastal County and Launch Point

Coastal County	Launch Point	Composite Site	Number of Observations
Beaufort	701	Pamlico	8
	702	Pamlico	1
	713	Pamlico	7
	716	Pamlico	9
	717	Pamlico	1
Camden	402	Albemarle	1
	404	Albemarle	18
Carteret	612	Outer Banks	6
	620	Outer Banks	1
Chowan	301	Albemarle	66
	302	Albemarle	20
	303	Albemarle	2
	305	Albemarle	6
Craven	803	Pamlico	16
Dare	408	Albemarle	5
	502	Outer Banks	28
	504	Outer Banks	234
	506	Outer Banks	2
	601	Outer Banks	2
	604	Outer Banks	1
	605	Outer Banks	17
	607	Outer Banks	4
	608	Outer Banks	15
	619	Outer Banks	6
Hyde	615	Pamlico	7
	616	Pamlico	6
	618	Pamlico	11
Pamlico	614	Pamlico	30
	802	Pamlico	6
	804	Pamlico	5
	805	Pamlico	30
Pasquotank	403	Albemarle	1
Tyrrell	310	Albemarle	3
	311	Albemarle	4
Washington	308	Albemarle	32

two sites. Equally important, the Outer Banks entry points are also quite different from the other two areas. Because of the differences in local conditions and points of access, the launch sites in this area were included in a third group as our third site even though the fishing within the barrier islands would be in one or the other of the two Sounds. Separate models were estimated for each of these three areas (which we will refer to as Albemarle, Pamlico, and Outer Banks).

The specific details of implementing these models are important, because earlier studies have also used aggregated sites. In our case the travel cost and characteristics of launch points vary based on the characteristics of each respondent (and his trip) and the specific entry point that was selected. The process of grouping entry points into what we have referred to as a composite site is then simply a restriction on the demand parameters. Thus, even though the implicit price to reach the Outer Banks entry point for one individual may differ from another, the effect of a small change in that price on our measure of the quantity demanded is the same for all entry points included in the "site."[4] This same assumption will be maintained for each of the specified determinants of site demand.

This approach contrasts with the approaches that have been used in the literature. For example, the Bockstael et. al. [1986] analysis of marine fishing in South Carolina aggregated trips each individual made to several different entry points and then constructed an aggregate price index to measure the implicit price. In contrast, Morey et. al.'s [1988] random utility model used distance from each respondent's origin county to the same location in each coastal county to measure the implicit costs of trips to sites.[5] Coastal counties were treated as the sites. Both of these approaches reduce the variability in the implicit prices individual recreationists paid for their trips.

Our approach has an additional advantage over these methods. Because there are variations in the conditions at each entry point, this grouping of launch points allows us to investigate whether these differences in conditions were important features to individual's demand. Recall that Chapter 4 described the estimation of catch rates by entry point and the development of fairly crude proxy measures for the environmental quality of sites based on several different estimates of the pollutants entering the sounds. These are the features we can use to evaluate how demand responds to measures of the quality of launch points.

This formulation is comparable to the so-called regional travel cost models discussed in Chapter 2. However, there are some important differences between our model and these earlier efforts. Most previous implementations of regional travel cost models have covered a much larger geographical area. For example, Sutherland [1982] combined recreation experiences from several states in the Northwest, and Loomis, Sorg, and Donnelly [1986] considered fishing throughout Idaho, although they also considered some smaller areas. The three areas used in the current study are much more localized, so there may be less of a problem with important differences that cannot be measured. Also, some regional travel cost studies (e.g. Sutherland, [1982]) have considered several types of recreation within the area, whereas we only consider marine recreational fishing. Because we are estimating a derived demand for a site's services, this homogeneity in activities undertaken at the sites makes the grouping more plausible.

There is also a close correspondence between our model and the varying parameter framework initially proposed by Vaughan and Russell [1982] and subsequently applied by Smith and Desvousges [1985, 1986]. However, just as our model differs from the usual regional travel cost models, our analysis also differs from the usual varying parameters model since the locations are in close geographic proximity and the activities are comparable. Most varying parameters models have used large regions (some as large as nationwide).

Because the grouping of entry points plays an important role in our ability to investigate the influence of the quality of fishing conditions for site demands, the implicit assumptions connecting our empirical demand models to underlying behavioral functions should be considered. Different theoretical models can generate the empirical models we use. One possibility would be to adopt the conceptual arguments used to explain the implicit theoretical restrictions underlying a varying parameters model. These models have often used a two-stage estimation procedure: first estimating a travel cost model for each site, and then attempting to explain the differences in the estimated parameters associated with each specified determinant of demand across sites with a set of characteristics of the sites (Vaughan and Russell, [1982]; Smith and Desvousges, [1986]). The logic underlying these models is similar to what we discussed in Chapter 2 in that it assumes all sites' services can be converted into a single scale, once the site characteristics are known. Moreover, the form of the conversion function must be simple with the homogeneous measure of site services, say V^*, a multiple ($h(a_j)$) of each site's services, say V_j, that changes with the attributes (a_j) of each site, as in equation (1).

$$V^* = h(a_j) \cdot V_j \tag{1}$$

The overall implication of this framework is that all substitution possibilities are captured through the h(•) conversion function. Recreationists select the least cost site for obtaining the homogeneous services measured in terms of these effective units. This usual varying parameters model is not especially appealing for the Albemarle-Pamlico Sounds because of these assumptions of homogeneous services and the absence of substitution possibilities. However, one could assume there were significant differences between the Outer Banks, Pamlico, and Albemarle areas, but within one of those areas the coefficient of price would be influenced by the quality of the launch site. This would avoid the necessity of accounting for the possibly unquantifiable differences between the three areas. It also allows for the possibility that the implicit prices of recreation in the substitute areas influence the demand for recreation.

The number of visits to each launch site (V_i for launch site i, where V_i could be a transformation of the number of visits such as the natural logarithm of visits) is explained using travel cost, income (Y), the price of substitute areas (S), and other relevant variables:

$$V_i = a + b_i \cdot TC_i + c \cdot Y + d \cdot S. \qquad (2)$$

Here the subscripts for the individual observations are omitted, as are the error term and the other variables that may influence the site demand. It is assumed that the characteristics of the site explain differences in the coefficient of travel cost so that b has an i subscript. A full varying parameters model would allow the constant and income coefficient to vary with the site characteristics as well. We tested specifications with the constant varying with catch (catch entering separately), although that is not shown in the equation used here. Our reasons for not having the income coefficient vary with quality are discussed below. The coefficients b_i are explained by the characteristics of the sites (expected catch rate, CATCH, in this example):

$$b_i = \alpha + \beta \cdot CATCH. \tag{3}$$

A single-stage estimation technique combines these two equations, and estimates

$$V_i = a + \alpha \cdot TC_i + \beta \cdot TC_i \cdot CATCH + c \cdot Y + d \cdot S. \tag{4}$$

An alternative theoretical model that could generate a related estimating equation transforms the number of visits in the direct utility function by incorporating quality in a specific manner (see Bockstael, Hanemann, and Strand, [1986]). This technique is closely related to the methods used for incorporating demographic information in the estimation of systems of demands (e.g., Pollak and Wales, [1976]). Of the various transformation techniques available, the model implied by translating can yield demand equations similar to what we have estimated. More specifically, assume that an individual's utility depends on the number of visits to a site V_i, and a term that depends on the quality of the site, f(catch rate), with the catch rate used as our measure of quality. Thus, V_i is replaced by V_i + f(catch rate). With this change the general form of the demand function would be given as equation (5).

$$D(TC, CATCH, Y) = D_o(TC, Y - TC \cdot f(CATCH)) - f(CATCH), \tag{5}$$

where $D_o(\cdot)$ is a demand function derived from the basic utility function and $D(\cdot)$ is the demand function incorporating quality. Thus CATCH enters separately as well as multiplied times travel cost and subtracted from income.

If the income term enters the estimated demand function linearly, then CATCH RATE will enter linearly and in an interaction term with the price (in our case the travel cost).

A third potential approach to investigating the role for quality in a recreation site demand model would be to ask under what conditions would we expect that the use values associated with that site capture the full value of the quality? Recently Bockstael and McConnell [1987] have considered this question. The answer follows as an extension to what Mäler [1984] termed weak complementarity.

Weak complementarity arises when an individual's value for a non marketed good or service is linked to the consumption of another commodity in a specific way. The specific linkage implies that the non-marketed service is not valued if the other commodity is not consumed.

In our case, this means that we would assume improvements in the quality of the sounds are not valued by recreationists if they don't use the areas. At first, this assumption may seem quite reasonable. However, there are situations in which it would omit a substantial share of the benefits of a quality improvement. When individuals are concerned about the quality of the area, independent of any plans they have for using it, then nonuse values will also be important components of the benefits generated by policies to enhance the quality of the sounds. These benefits cannot be measured with travel cost methods. Only survey techniques provide the means to recover this component of nonuse values.[6]

Thus, if we assume that the only reason for valuing quality enhancements is because of recreational uses (and in our case only marine fishing) we are adopting a conservative strategy for benefit estimation - one that is likely to understate the benefits of quality improvements.

Using this strategy we might consider formulating a model specified so that quality satisfies the conditions required to use these demands to measure the full value of a quality improvement. Bockstael and McConnell summarize these conditions drawing upon Mäler [1974] and Willig [1978]. More specifically, Willig demonstrated that if the services of the recreation site are not essential to the consumer (i.e. a zero consumption level is feasible), quality and the services of the recreation site are weak complements (in Maler terms); and if the consumer surplus from a quality change per unit of use is independent of income, then the area between Marshallian demand functions defined by the two quality levels associated with the quality change will measure the value of that quality change.[7] This implies that if we assume there are interaction terms between quality measures and other determinants of site demand, these should not involve income. Otherwise we would not have a complete measure of the value of a quality change.

Of course, it is important to recognize that in practice we simply do not know whether this assumption is correct. Our strategy is to maintain it. To assure consistency in our benefit estimates and because of the associated requirement of weak complementarity, we are developing conservative estimates of the benefits of a quality change.

To meet this requirement and follow the general logic of a regional travel cost model, we might hypothesize that our site demand function for our site was given by equation (6).

$$\ln V_j = a + b\, TC_j + c\, STC_j + d\, Y \qquad (6)$$

where:

V_j = visits to site j

TC_j = travel cost (including vehicle and time cost) to site j

STC_j = one (or more) substitute site's travel cost that are relevant to site j

Y = income

This structure would imply that a, b, and c could be expressed as functions of measures of site quality, and d would not. Of course, only a specification that allowed a and b to be functions of quality would also be consistent with the method of translation used to incorporate quality variables in utility functions.

Overall, the net result of this discussion is that there are conceptual and practical implications of specifying a role for quality in consumer demand. As Bockstael and McConnell [1987] have indicated, there is not one specific role for quality in preferences that dominates others. What is clear is that our ability to measure how individuals' value quality, in the absence of observable price differences across quality differentiated goods, is affected by what we are willing to assume.

We have suggested several of the current arguments for alternative treatments of quality. Our preferred hypothesis is one that will yield consistent (and likely conservative) estimates of benefits. Of course, one might also argue that we could test for a role for quality by comparing alternative models and measures. We have done this. However, it is important to recognize that the collinearity generated by treating quality measures in combination with alternative sets of variables will impede our ability to discriminate between them. Consequently, as a practical matter, judgment and *a priori* conceptual criteria are often the only standards that can be applied in practice to select a form. Such selections should be evaluated to determine whether they affect in important ways the conclusions derived from the analysis.

The criteria for selecting a functional form for the travel cost demand model are equally diverse. As we observed in Chapter two, a consensus form or procedure for selecting one has not emerged in the literature of model selection or, more narrowly, from the practice of estimating travel cost demand models in different applications. Nonetheless, it does appear that the semi-log specification has often emerged as a preferred specification. We considered it as well as a linear model (see the appendix 7). There was a clear preference, in terms of our ability to estimate the effects of own price, substitutes' prices, and quality for the semi-log specification.

Can a system of semi-logarithmic demand equation be derived from a well-behaved utility function? In general, the answer is no. Nonetheless we can develop consistent measures of the welfare change associated with a change in the conditions of access to the resource. That is, if we assume that the prices of goods other than recreation move together so that they can be aggregated to form a Hicksian composite commodity with only two goods, mathematical integrability problems are all but eliminated. This is the key insight provided independently by Hanemann [1978] and Hausman [1980]. The implications for our particular specification have been developed by Bockstael, Hanemann, and Strand [1986] and Smith and Desvousges [1986] who demonstrate that a quasi-indirect utility function can be derived from the semi-log form so it can be used to measure the Hicksian consumer surplus for price changes. In the notation of equation (6) this function is given as:

$$U(TC,Y) = [-\exp(-dY)]/d - [\exp(b \cdot TC + \bar{a})/b.] \quad (7)$$

where $\bar{a} = a + c\ STC$

Roy's Identity can be used to verify that this indirect utility function gives rise to a semi-log demand equation. Economic integrability requires that $b + dV$ be less than or equal to zero.[8]

5.3 Empirical Results

A crucial variable in demand estimation is price. As we observed in Chapter 2, the key insight of the travel cost model arises in the recognition that travel costs can serve as an implicit price of using a recreation site. These costs include costs that are specific to the site visited. These include the vehicle related travel costs, opportunity costs of travel time and the fees for using boat launches for a owners' private boats or charter fees for those using commercial boats. To estimate these costs requires assumptions about the mode of travel, speed, and vehicle costs. (See Chapter 4 for the details.) Converting travel time to time cost requires information on the value place on travel time by the individual. As Chapter 2 indicated, most studies on the value of time have found that the value is related to the wage rate, although the relationship has varied. The models reported here have assumed that the opportunity cost of travel time was valued at the wage rate measured in two ways - from a hedonic wage model and from household income (see Appendix 7). Models were also estimated valuing time at one-third the wage rate with some differences in the results. Overall, the models did not indicate as strong a relationship to trips and were not pursued further in our analysis.

Given estimates of the implicit cost of making a trip to the specific site, it is also important to consider if each respondent should be assumed to be responsible for these full costs. Equally important, the survey asked the number of days the individual would be in the area as well as the number of days that would be spent fishing. The travel costs (including time costs) could be allocated to the fishing experience according to the percent of time on the trip that would be devoted to fishing. To address the responsibility for trip costs, a second cost allocation issue must be considered. It will depend on the make-up of the party. When the party is all family members, all travel costs can be attributed to that household; but when the party members are unrelated, we might assume that the costs are shared by the party members.

The nature of the questions asked on the survey created a problem in clearly distinguishing these types of parties. The questionnaire identified situations when there were family members in the party, as well as when there were nonfamily members in the party, but it did not allow us to determine how many of each type. Thus, costs could be allocated if the party was all family or all non-family, but not if there was a mixture of the two types. This reduced the number of usable observation for those models where we allocated the non-time-related travel costs based on the sample composition when costs were allocated this way.

There are good reasons to question these allocations. The first and most important of these follows from our discussion of the limitations of our measure for the quantity demanded. Any allocation procedure we use assumes that the features of the trip when the Sea Grant interview was undertaken accurately characterizes all of that person's trips during the last year. This means that any features important to the allocations we have considered must be identical for all of these trips. For example, if the trip of the interview involved a party of four nonfamily members we might allocate the vehicle-related travel costs and fees in four shares, so the respondent's travel cost would be the opportunity costs of travel time plus one-fourth of these fees and other travel costs. We would need to assume that this same allocation governed all his trips in the past year. Similarly if the current trip was with family members, we must assume all of last year's trips would be the same.

A second qualification arises in our computation of costs for family members. If the family decided upon recreation trips as a unit, then we might also consider treating the time costs as having contributions for all adult members of the party. This was not done in our evaluation of the family costs. We do not have sufficient information on the other party members to impute wage rates to them. Nonetheless, this would be an issue to consider if more complete information were available. The regressions reported in this chapter use the prices imputed from the hedonic wage study with no costs allocations because of these qualifications. In Appendix 7 the results with other price definitions are presented.

The catch variable also requires some discussion. For each person surveyed as they returned to the launch site, the number of fish caught and used for bait were solicited. This record is for the party as a whole and reflects their experience during the trip when the interview occurred.[9] This variable will reflect both the overall availability of fish and the effort each party has expended to catch them. Effort involves both time and gear inputs. While the survey included information on gear, there were not sufficient observations in our sample to allow meaningful disaggregation. Thus, we cannot account for the potential effect of this factor.[10] We do have information on the time spent fishing and the party size, so we measure a catch rate using the total fish caught (in all of the above categories reported) per person per hour.

Ideally, we would like to measure the perceived quality of a site by the individuals' expectations about the amount of fish, their type and quality (e.g. likelihood of catching particular fish, the size distribution, etc.). This expectation is what would govern site selection. This information is not available. Consequently we have assumed that each person's expectations of fishing quality (in all these dimensions) is adequately captured by an average of the actual experiences of respondents launching from each of the entry points. Thus, we have entry-specific, average catch rates. This average catch rate over all fishermen using a site was assigned as the expected catch for that site. While our final measure uses all fish caught, three different average measures were considered: fish kept; fish kept or released; and fish kept, released, or used for bait. The last of these was used because it proved to have the greatest explanatory power.

When the prices at substitute area were desired, these were formed by calculating the travel and time costs to all sites in the alternative area for each respondent. The average of these costs plus average launch fees ($.40 per trip) was used as the price of the substitute area. For each area there were two substitute prices. For example, in the Outer Banks area the two substitute prices are the average cost of using sites in the Pamlico and Albemarle areas. This formulation is consistent with our treatment of each of these groups of entry points as composite demands. Each entry point is an equally likely substitute from the individual's perspective and can be viewed as a composite commodity.

Before discussing the specific estimates and their implications two further issues arising from our measure of the quantity should be considered. First, because the data source is an intercept survey we do not observe individuals who do not visit the site. In economic terms we do not learn about the choke price (price at which the quantity demanded will be zero). As we discussed in Chapter 2, this implies some adjustment in the estimator is warranted. Ordinary least squares (OLS) will, in theory, be biased. The specific form we have used for the demand function, a semi-log function with the log of trips as the dependent variable, may be less subject to this problem, because it does not have a price intercept.[11]

In practice the effects of this truncation at one trip will depend upon the actual distribution of trips reported by respondents. In our case, the assumptions involved are somewhat different than the typical case because our quantity is for the last season, rather than a report of expected trips (past and anticipated future). We have treated the problem as one inducing a truncation (e.g. this year's sample is representative of last year's) and utilized the maximum likelihood estimator, adjusting for truncation effects as described in Chapter 2. Because our respondents reported one or more trips in the previous year (implying a log (trips) = 0), we use a small negative value as the truncation point and thereby include observations with one trip.

A second concern arises from the length and objectives of these trips. While our cost allocations considered several possibilities, in this case the allocation is limited by several considerations. We must assume all of last year's trips are the same as the one described for the interview. There are two important aspects of these allocations from a theoretical perspective. The first concerns the objectives of the trip (and parallels the issues raised by Haspel and Johnson [1982] and discussed in Chapter 2), while the second relates to the nature of the prices for our measures of site services. When trips have objectives other than fishing, there is a need to allocate costs to each objective. Typically there is no theoretically correct way to allocate joint costs. When the trip accomplished multiple objectives (i.e. produces multiple outputs in a household production framework), any allocation of the joint costs will be arbitrary. We considered allocating costs based on the fraction of the total trip length that was spent fishing.

The second theoretical concern also relates to trip length. To the extent trips are of different lengths across respondents, we must consider whether the assumption of a fixed price per unit of site use (differing according to respondents' locations and opportunity costs of time) is reasonable. In a model of individual behavior this implies that there are fixed and variable costs of trips with varying length. In principle this leads to the potential for a nonlinear budget constraint and the inability to define conventional Marshallian demand functions.[12]

If we can assume all trips are the same length, we avoid these issues. Once again, our sample is too small to subsample by length of trip, estimate separate demand functions, and then maintain only that all of last year's trips were the same. Instead, we report two alternatives: a demand model where the implicit price is adjusted for the proportion of time spent fishing, as well as where the trip costs are allocated by party composition, and a second model using the original implicit price concept but instead proposing an approximation to the Smith-Kopp argument by considering only those respondents within 200 miles (400 miles round-trip) of the entry points. The argument for using travel cost as a gauge of the extent of the market relies on the homogeneity in length of trip, prospects for multiple-objective/ multiple-destination trips and other considerations that are implicit assumptions of the model, as we have already discussed in Chapter 2.

Among our three samples (for the three composite sites) this is only a meaningful restriction to the sample with the Outer Banks site. As we suggested in Chapter 4, most of the recreational fishing in the area is local. We report two sets of estimates - full sample and respondents within 200 miles for the Outer Banks demand equations.

The demand estimates for each of these areas - Outer Banks, Pamlico and Albemarle - will be described in turn. The results for the Outer Banks, where there were the most observations, were quite good with the important variables having the anticipated signs and being statistically significant at fairly high levels. The results for the Pamlico area with the selected regressions were generally of the right sign, although in some cases the statistical significance was less than for the Outer Banks. On the other hand, the results for Albemarle were largely noninformative and not consistent with conventional demand models.

Table 5.2 defines the variables used in our analysis and reports the means for the samples used with each of our composite sites. Our model development followed a sequential process, beginning with fairly simple specifications including only one price - the implicit own price or travel costs to each site - and a measure of household income. To this specification we added demographic and socioeconomic variables that have been found to be significant

TABLE 5.2

Variable Definitions and Means by Sample[a]

Variable Name	Definition of Variable	Means Outer Banks	Means Pamlico
Trips	The number of trips the respondent reported taking for fishing in the season preceding the interview.	30.7	34.3
Travel Cost[b]	The sum of vehicle related travel cost (.20 x round-trip distance measured from designated location in origin county to entry point) plus the opportunity cost of travel time (predicted wage rate times estimate of time assuming 40 miles per hour speed) plus reported fees (launch or charter).	$203.77	92.13
Income[b]	Household income derived from the the reported interval codes in the N. C. Sea Grant Survey.	32,174	31,759
Years Fishing	Number of years respondent indicated he (or she) has undertaken sport fishing.	24.1	24.4
Age	Respondent's age in years	43.7	45
Boat Ownership	Qualitative variable indicating whether the respondent indicates he owns a boat (1 = owns, 0 = otherwise).	.87	.90
Catch Rate	Average of the total reported fish caught per person per hour for all respondents using each of the entry points; calculated for each entry point.	2.63	2.89
Pamlico Travel Cost[b]	The average value of vehicle related travel cost and opportunity costs of time for entry points identified as in Pamlico site; calculated for each respondent plus $.40 cents (the sample average launch fee)	177.50	-

Table 5.2 (continued)

Variable Name	Definition of Variable	Means Outer Banks	Means Pamlico
Albemarle Travel Cost[b]	The average value of vehicle related travel cost and opportunity costs of time for entry points identified in Albemarle site calculated for each respondent plus 40 cents.	161.83	129.07
Outer Banks Travel Cost[b]	The average value of vehicle related travel cost and opportunity costs of time for entry points identified in Outer Banks site calculated for each respondent plus 40 cents.	-	184.01

[a] The means for Albemarle subsample are not reported here because the models are not used in subsequent analysis.

[b] Because the two surveys actually fall within a seventeen month period with percentage change the consumer price index for recreation related commodities we have not attempted to adjust for the modest cost-of living effects induced by the different years of the survey and treat it as a simple decision period from the perspective of price calculations and income.

influences in other studies, as well as our catch variable, entered in a linear, additive form. Table 5.3 reports selected results for the Outer Banks site, estimated with ordinary least squares. It includes two models for the two samples. A semi-log demand with own price, income, years fishing, age of the respondent, and a qualitative variable for boat ownership is the first demand specification. This same model including the catch rate measure of fishing quality is the second. The two samples are distinguished by whether respondents traveling more than two hundred miles (one way) are excluded.

The first column of Table 5.3 reports the OLS results with the basic specification. With the exception of boat ownership, all of the variables have the expected signs and are statistically significant. As the cost of the trip goes up, the number of visits decreases. The fact that the coefficient of income is highly significant is particularly noteworthy because many other recreation demand studies for other types of recreation sites have failed to find significant income effect. Experience, measured by years fishing, has the anticipated positive effect on the number of visits. The coefficient of age seems reasonable when one considers that the years fished variable is correlated with age and provides a proxy for interest, so age may capture the effects of time constraints. While this is a common finding in travel cost demand models for many types of recreation facilities, few of the examples cited in Chapter 3 can be used to compare these estimates with. Most of the complete models are random utility frameworks designed to explain site selection for each trip occasion as an independent decision. Moreover, few contain age in their demographic variables. Only Milon [forthcoming] included age, and he also found a negative effect on the offshore/near-shore choice

TABLE 5.3

Outer Banks Demand Models:
OLS Estimates for Basic Models[a]
Dependent Variable: Natural Logarithm of Trips

Independent Variables	Full Sample		Within 200 Miles	
	(1)	(2)	(3)	(4)
Intercept	3.126 (10.182)	2.805 (6.422)	3.388 (8.899)	3.390 (6.267)
Travel Cost	$-.11\times10^{-2}$ (-2.833)	$-.11\times10^{-2}$ (-2.856)	$-.54\times10^{-2}$ (-3.448)	$-.54\times10^{-2}$ (-3.435)
Income	$.10\times10^{-4}$ (2.832)	$.10\times10^{-4}$ (2.846)	$.13\times10^{-4}$ (2.728)	$.13\times10^{-4}$ (2.718)
Years Fishing	.036 (6.143)	.036 (6.041)	.030 (3.812)	.030 (3.776)
Age	-.027 (-4.027)	-.027 (-3.898)	-.021 (-2.278)	-.021 (-2.252)
Boat Ownership	-.107 (-0.578)	-.120 (-0.643)	-.135 (-0.560)	-.134 (-0.556)
Catch Rate	------	.119 (1.035)	------	$-.05\times10^{-2}$ (-0.004)
n	252	252	150	150
R^2	.188	.191	.196	.196
F	11.37	9.66	7.00	5.80

[a]The numbers in parentheses below the estimated coefficients are the t-ratios for testing the null hypothesis of no association. A value of 1.96 in absolute values indicates this hypothesis can be rejected at the 5 percent level.

in his nested logit model. Among the early recreation studies, Cicchetti, Seneca and Davidson [1969] found that both the likelihood of engaging in fishing (of all types) and the level can be negatively related to age. Their level of participation equation exhibited a parabolic effect for age with initial decreases and then increases after about 45.[13]

When the same specification was used for the observations within 200 miles, the results were quite comparable. The magnitude of the coefficient of the price variable increased substantially in absolute value, and its statistical significance increased still further. One basis for comparing the models that is especially relevant to our overall goal is the implied estimates of the consumer surplus per trip with changes in sample composition and other modeling assumptions. This is an easy comparison to make for the semi-log form. The consumer surplus per trip will be the absolute value of the inverse of the price variable's coefficient.[14] At this simplest level, the Marshallian surplus is quite sensitive to the sample used: $909 versus $185 for the model based on respondents within 200 miles. We return to this issue below in evaluating our final models for each site.

When the specification was changed by adding the average catch rate for the site, the effects on the coefficients of the other variables were almost unchanged. The coefficient of catch was positive for the full sample, as expected, but negative for the subsample. In both cases it was not statistically significant. Thus, at this stage the link with site quality would be judged to be tenuous.

Table 5.4 presents our refinements in the regressions for the Outer Banks. The first four columns are for the full sample, providing OLS and the

TABLE 5.4

Outer Banks Demand Models: Final Models with OLS and Truncated Maximum Likelihood (TML) Estimators[a]
Dependent Variable: Natural Logarithm of Trips

Independent Variables	Travel Cost Models							
	Full Sample				Respondents Within 200 Miles			
	(1)		(2)		(3)		(4)	
	OLS	TML	OLS	TML	OLS	TML	OLS	TML
Intercept	3.153 (10.327)	3.168 (10.201)	3.030 (9.921)	3.038 (9.836)	2.930 (8.724)	2.926 (8.721)	2.747 (7.110)	2.742 (7.186)
Travel Cost	$-.28\times10^{-2}$ (-3.012)	$-.29\times10^{-2}$ (-3.056)	$-.41\times10^{-2}$ (-2.549)	$-.42\times10^{-2}$ (-2.543)	$-.64\times10^{-2}$ (-1.884)	$-.65\times10^{-2}$ (-1.913)	$-.91\times10^{-2}$ (-2.709)	$-.93\times10^{-2}$ (-2.781)
Income (Dollars)	$.10\times10^{-4}$ (2.772)	$.10\times10^{-4}$ (2.819)	$.10\times10^{-4}$ (2.763)	$.10\times10^{-4}$ (2.818)	$.76\times10^{-5}$ (1.802)	$.77\times10^{-5}$ (1.841)	$.10\times10^{-4}$ (2.257)	$.10\times10^{-4}$ (2.322)
Years Fishing	.036 (6.022)	.037 (6.045)	.033 (5.705)	.034 (5.733)	.030 (4.368)	.031 (4.444)	.025 (3.302)	.026 (3.389)
Age	-.026 (-3.889)	-.028 (-3.938)	-.024 (-3.586)	-.025 (-3.637)	-.022 (-2.914)	-.023 (-2.967)	-.014 (-1.617)	-.015 (-1.671)
Boat Ownership	-.126 (-0.683)	-.125 (-0.661)	-.149 (-0.823)	-.151 (-0.819)	-.223 (-1.054)	-.226 (-1.070)	-.198 (0.870)	-.201 (-0.893)
Catch1* Travel Cost	$.62\times10^{-3}$ (2.041)	$.63\times10^{-3}$ (2.062)	$.59\times10^{-3}$ (1.996)	$.61\times10^{-3}$ (2.015)	$.27\times10^{-2}$ (2.181)	$.28\times10^{-2}$ (2.224)	$.12\times10^{-2}$ (1.152)	$.12\times10^{-2}$ (1.196)
Pamlico Travel Cost	--------	--------	$.56\times10^{-2}$ (2.875)	$.56\times10^{-2}$ (2.863)	$.83\times10^{-2}$ (3.721)	$.85\times10^{-2}$ (3.789)	.010 (4.186)	.010 (4.290)
Albemarle Travel Cost	--------	--------	$-.37\times10^{-2}$ (-1.392)	$-.36\times10^{-2}$ (-1.317)	$-.84\times10^{-2}$ (-3.400)	$-.86\times10^{-2}$ (-3.462)	$-.40\times10^{-2}$ (-1.044)	$-.40\times10^{-2}$ (-1.057)
n	252	252	252	252	185	---	150	150
R^2	.201	---	.236	---	.211	---	.298	---
F	10.29	---	9.40	---	5.88	---	7.50	---

[a]The numbers in parentheses below the coefficients are the t-ratios for OLS and ratios of estimated coefficients to their estimated (asymptotic) standard errors. We have used the same approximate criteria as described in Table 5.3 to test null hypothesis of no association in both cases.

truncated maximum likelihood (TML) estimates for each of two specifications of the model. This first of these includes the catch rate in interaction form with the travel cost. The second adds to this model the "average" travel costs each respondent would incur for the other two composite sites to reflect the effects of substitutes.

This catch rate/travel cost interaction is what our theoretical arguments would imply should be considered. The coefficient is positive and significant as hypothesized. When both the interaction term and catch rate alone were entered, catch rate had almost no effect on the regression, with the other coefficients staying almost identical and the coefficient of catch rate being small and statistically insignificant.

Column 2 suggests that the TML estimator has little effect of the estimates, but it is a more appropriate estimation method. Columns 3 and 4 report OLS and TML estimates for the models with the substitute price terms. The sign and significance of the coefficient for Pamlico travel cost indicates that the Pamlico is a substitute for recreation at the Outer Banks. The effect of the Albemarle price index is negative and generally not significant.

The next two columns repeat our most general specification (i.e. that of columns 3 and 4) with an allocated measure of the travel cost. This allocation involves two separate issues - party composition and activities undertaken during the trip. We assume that trips composed of family members bear the full costs of the vehicle-related travel costs, launch fees, and the opportunity costs of time. As we discussed earlier, those respondents in parties composed exclusively of unrelated individuals have the costs not associated with travel time allocated equally among the party and incur the full cost of the travel time using their relevant opportunity cost of time. In addition, the result of these allocations is then attributed to marine fishing depending on the number of days spent fishing relative to the total number of days in the trip of the interview. As we noted, these adjustments are assumed to be relevant for all the trips reported to have been undertaken in the year before the survey.

Because this process cannot be applied to parties made up of a combination of family members and nonfamily members, the sample size is considerably smaller. Nonetheless, both the OLS and TML models seem to be at least as good as the models without adjustments to the travel cost. Moreover the interaction term between catch rate and travel cost is somewhat more significant than with the other models. The signs and significance of other variables are comparable to the full sample with one exception. The effect of Albemarle travel cost is now significant but remains a negative effect, suggesting some complementary relationship that should not be surprising given the geographic relationship between the sites involved (see Figure 4.1). Interestingly, the effect of own price increases in absolute magnitude as we attempt to adjust for potential shortcomings in our assumptions from the full sample to the adjusted and then to the within 200 mile samples. The consumer surplus per trip interpretation is more complex in this case because of the interaction term with the catch rate, so we defer further discussion of this issue until the end of this chapter.

The last two models involve the sample of respondents within 200 miles and are generally similar in overall implications (aside from the absolute magnitude of the price coefficient) to the other findings. It is notable that support for the catch rate interaction term is not clear-cut here.

Similar regressions for the Pamlico area are reported in Table 5.5, but as we noted, separate regressions for less than 200 miles are unnecessary since

TABLE 5.5

Pamlico Demand Models: Simple and Final Models
With OLS and Truncated Maximum Likelihood (TML) Estimators[a]
Dependent Variable: Natural Logarithm of Trips

Independent Variables	(1) OLS	(1) TML	(2) TML	(3) TML
Intercept	2.858 (5.023)	2.848 (5.020)	3.336 (4.458)	3.343 (4.463)
Travel Cost	$-.26\times10^{-3}$ (-0.641)	$-.27\times10^{-3}$ (0.654)	-.013 (-3.293)	-.013 (-3.268)
Income	$-.50\times10^{-5}$ (-0.901)	$-.51\times10^{-5}$ (-0.924)	$-.21\times10^{-5}$ (-0.400)	------
Years Fishing	.019 (1.984)	.019 (2.033)	.013 (1.492)	.012 (1.437)
Age	-.012 (-1.148)	-.012 (-1.179)	-.007 (-0.708)	-.007 (-0.700)
Boat Ownership	.407 (1.175)	.418 (1.203)	.075 (0.236)	.085 (0.267)
Catch1* Travel Cost	----	----	$.11\times10^{-2}$ (1.562)	$.11\times10^{-2}$ (1.541)
Outer Banks	----	----	-.015 (-1.912)	-.016 (-2.184)
Albemarle Travel Cost	----	----	.025 (3.614)	.026 (3.926)
n	108	108	108	108
R^2	.06	----	----	----
F	1.30	----	----	----

[a]The numbers in parentheses below the coefficients are the t-ratios for OLS and ratios of estimated coefficients to their estimated (asymptotic) standard errors. We have used the same approximate criteria as described in Table 5.3 to test null hypothesis of no association in both cases.

almost all trips to the Pamlico area originated within 200 miles. The results are somewhat less robust than for Outer Banks. With the incomplete specification in Column 1, the price coefficient is insignificant. Only when the more complete specification is used, including the interaction term and substitute prices, do we find estimates somewhat comparable in quality to the Outer Banks models. The magnitude and significance of the price coefficient increase substantially in absolute value terms. The catch interaction term has the expected sign and magnitude, but the statistical significance is less than in the Outer Banks estimates. The last column of Table 5.5 was added to gauge the effects of deleting income, because the coefficient of income was not significant and had a negative estimated effect on demand. The last column reports the TML regression with income omitted, but the results are unchanged.

A few of the results for the final area, the Albemarle, are reported in Table 5.6. These regressions indicate that there is a problem with the data or the model in this area. The coefficient of travel cost is always positive and sometimes significant, while the coefficient of income is always negative. Catch rate has an estimated coefficient that is significant, but unfortunately it is negative. Because of these results, further analysis of the Albemarle sample was not pursued.

One method for comparing the results of these demand models across the alternative estimates for each composite site and between sites is in terms of their implications for the own price elasticity of demand and the consumer surplus per trip.

TABLE 5.6

Alternative Models
Albemarle, All Observations
Dependent Variable: LNTRIPS

	Model 1	Model 2	Model 3
Intercept	2.9661 (12.653)	2.971 (7.202)	3.3879 (7.930)
Travel Cost	.0037 (1.936)	.0035 (1.819)	.004 (2.146)
Income	$(-5.50E^{-6}$ (0.735)	-2.90×10^{-6} (0.384)	-2.80×10^{-6} (0.376)
Years Fishing		.0152 (1.396)	.0187 (1.760)
Age		-.0103 (1.033)	-.0101 (-1.046)
Catch Rate			-.0741 (-2.798)
n	118	116	116
R^2	.034	.051	.114
F	2.004	1.482	2.825

Table 5.7 summarizes these findings. Two important conclusions emerge from these comparisons. First, the model based on a complex cost allocation rule, including consideration of the stated time allocation of the interview trip and the composition of the party implies a positive own price elasticity. Thus, while the results appeared plausible in terms of the signs and statistical significance of the estimated demand parameters, the estimates incorporate too large a responsiveness to site quality. These computations were developed for the average catch rate, so they are not a result of extrapolating outside the range of sample experience. Because of this contradiction with an economic model of individual behavior (and especially because of the dramatic inconsistency with all our other estimates for the Outer Banks site), we have dropped this model from further consideration.

Second, the comparison of full versus restricted sample for the Outer Banks site indicates comparable price responsiveness but much larger consumer surplus estimates per trip for the full sample model. The estimate for the full sample would fall outside the range experience of most demand studies when converted to comparable dollars. This sensitivity of consumer surplus estimates per unit of use is consistent with recent research. Both Adamowicz et al. [1989] and Kling and Sexton [1989] report similar findings. Because the semi-log estimate of consumer surplus per unit is simply the absolute value of the inverse of the coefficient for the price, small changes in the coefficient (especially if the magnitude of response of demand to price is small) will be accentuated in the consumer surplus estimates.

Recently, Smith [[1989] used earlier research on the properties of nonlinear functions of random variables to explain this sensitivity. The

TABLE 5.7

Demand Elasticities and
Marshallian Consumer Surplus Per Trip

	Own Price Elasticity of Demand[a]	Marshallean Consumer Surplus Per Trip[a]
Outer Banks		
Full Sample	-.528	$385.98
Within 200 Miles	-.664	163.02
Allocated Costs	+.079	----
Pamlico		
Full Sample	-.897	102.71

[a]These estimates are computed using the average catch rate for each site along with the average travel cost.

inverse of the estimated price coefficient is a random variable whose distribution has no finite moments. Thus, the instability is not surprising.

At the same time, however, the information it provides as a screening device can actually improve the quality of the benefit estimates. Smith considered this issue in a preliminary set of sampling experiments and found that screening ordinary least squares estimates based on this consumer surplus estimate can improve their properties. Thus, wit this background research and the fact that the screened sample's estimates are more consistent with the existing literature, we have a slight preference for the model estimated using a sample of respondents within 200 miles.

5.4 Summary

This chapter has summarized the first set of estimates for the demand for marine recreational fishing in the Albemarle-Pamlico estuary. Overall, the empirical analysis has been quite successful, despite data limitations. Statistically significant and economically plausible demand models have been estimated for two composite sites. Moreover, the models do incorporate the effects of fishing quality as a potential determinant of individual demand. The overall implications of the models were generally stable and consistent across different specifications of the demand functions. The only notable exceptions to this conclusion arise with the need to explicitly account for the prices of substitutes and the form of the quality variable's influence on demand (i.e. as an adjustment to an individual's responsiveness to price changes). Finally, this form satisfies Bockstael and McConnell's conditions for developing consistent monetary measures of an individual's value of a quality change. Thus, the models can be used as a preliminary basis for measuring an important component of the recreational fishing values of alternative management policies.

Chapter 5

FOOTNOTES

1. Wilman's [1984] study of recreation in a large national park, The Black Hills, in North Dakota is a notable exception to this. The limited access points and substantial distance separating the areas involved could have easily justified treating the visit rates separately.

2. Of course, we might also expect that the area that can be accessed from any entry point will depend on the type of boat available to fishermen. Larger, more powerful boats can cover wider areas. This issue is one that could in principle be considered with this survey, but not with the conventional model, because it implies the type of equipment will offset the selection of launch points. We do not attempt to model this decision jointly in our analysis. Within a random utility framework, it would be possible to explore these types of issues.

3. This input was obtained from the public meeting held in Morehead City, N. C., January, 1988 at an early stage in the development of our analysis.

4. Of course, the implicit price can vary because of differences in the distance or in the opportunity costs of travel time across individuals.

5. For further discussion of the issues involved see Smith [1987], Freeman [1988] and Randall [1988].

6. More formally, Bockstael and McConnell [1987] develop the argument in terms of indirect utility functions and require that

$$\frac{\partial}{\partial y}\left[\frac{V_q}{V_p}\right] = 0$$

where V_q = partial derivative of the indirect utility function with respect to quality (q)

V_p = partial derivative of the indirect utility function with respect to the price of the weak complement (in our case the travel cost)

y = income

$\frac{V_q}{V_y}$ = the incremental consumer surplus for a change in quality

$\frac{V_p}{V_y}$ = the Marshallian demand for the weak complement (by Roy's identity)

Thus, $- \frac{V_q}{V_p}$ = the negative of consumer surplus of a quality change per unit of use of the recreation site.

Thus the Willig condition simply requires the gain from a quality change per unit of use of the complement to be constant.

7. As we observed in Chapter 2, there is some evidence that the consumer surplus estimates are more sensitive to the parameter estimates for the own price variable. However, we would argue, this result is at least partly a function of the way the Adamowicz et. al. [1989] study was designed.

8. Economic intergrability is simply downward-sloping Hicksian demand functions.

9. In the case of the bank fisherman the fish caught reflects the record as of the time of the interview and not the full catch for the specific fishing experience. Because we do not know how much longer they actually fished at each location, we cannot adjust to make these comparable to that obtained for the boat fishermen. Of course, this does not infringe on the results we report here. They concern only the boat fishermen. It does have implications for any future analysis the bank fishermen's responses to catch as a quality variable with these data.

10. This limitation arises both from the sample size and most especially the number of observations with complete information.

11. This feature is potentially in conflict with the assumption of weak complementarity, because the model does not allow demand to be zero. It is not an important issue from a practical perspective because when there is no interaction between quality and income and quality only enters in interaction with price, site quality will only be valued if trips are taken. It affects the value per trip. Bockstael and McConnell [1987] fail to mention this issue in their discussion of potential applications of their analysis.

12. Palmquist [1988] has discussed the prospects for developing demand functions in this case, following an early argument of Hall [1973] and Diewert [1974] on duality conditions for nonlinear budget constraints.

Smith, Desvousges and McGivney [1983] investigated the implications of a more ad hoc procedure for treating on site time and found it did not dominate ignoring the issue for all sites. The results were quite mixed.

13. This is an approximate computation because the variable was scaled in intervals of ten years each.

14. The specific result is derived in Bockstael and Strand [1987] and Smith and Desvousges [1986]. We develop it in more detail in the next chapter.

Chapter 6

Valuing Quality Improvements in the Albemarle-Pamlico Estuary

6.1 Introduction

The goal of comprehensive management plans mandated by the reauthorized water quality legislation is to reduce effluent loadings entering estuaries. Because these effluents have reduced the quality of estuarine resources over the past two decades, efforts to reduce the effluents can be expected to improve quality. To judge how much reduction is warranted, given the costs imposed by requirements to control effluents, it is important to evaluate the benefits provided by these improvements. Thus, one of the primary motivations for considering the quality of a resource in developing demand models for its services is benefit assessment. Our demand models reflect only one component of these benefits - the enhanced values to boat fishermen using the Albemarle-Pamlico estuary as a result of the improvements in fish stocks expected to accompany reductions in effluent loadings.

From an economic perspective, efficient management plans for any resource must consider both the benefits and the costs of alternative uses of the resource's services. At this general level, the economist's view of information supporting management plans would hold that an estuary is no different than any other resource supporting economic activities. Of course, the implementation of these broad principles raises significant issues. One of the most important of these questions arises in the importance assigned to use- and nonuse-related values generated by an environmental resource.[1] To the extent both are expressions of the real preferences of the group whose interests are to be served through a management plan (typically the general public), then both should be taken into account.

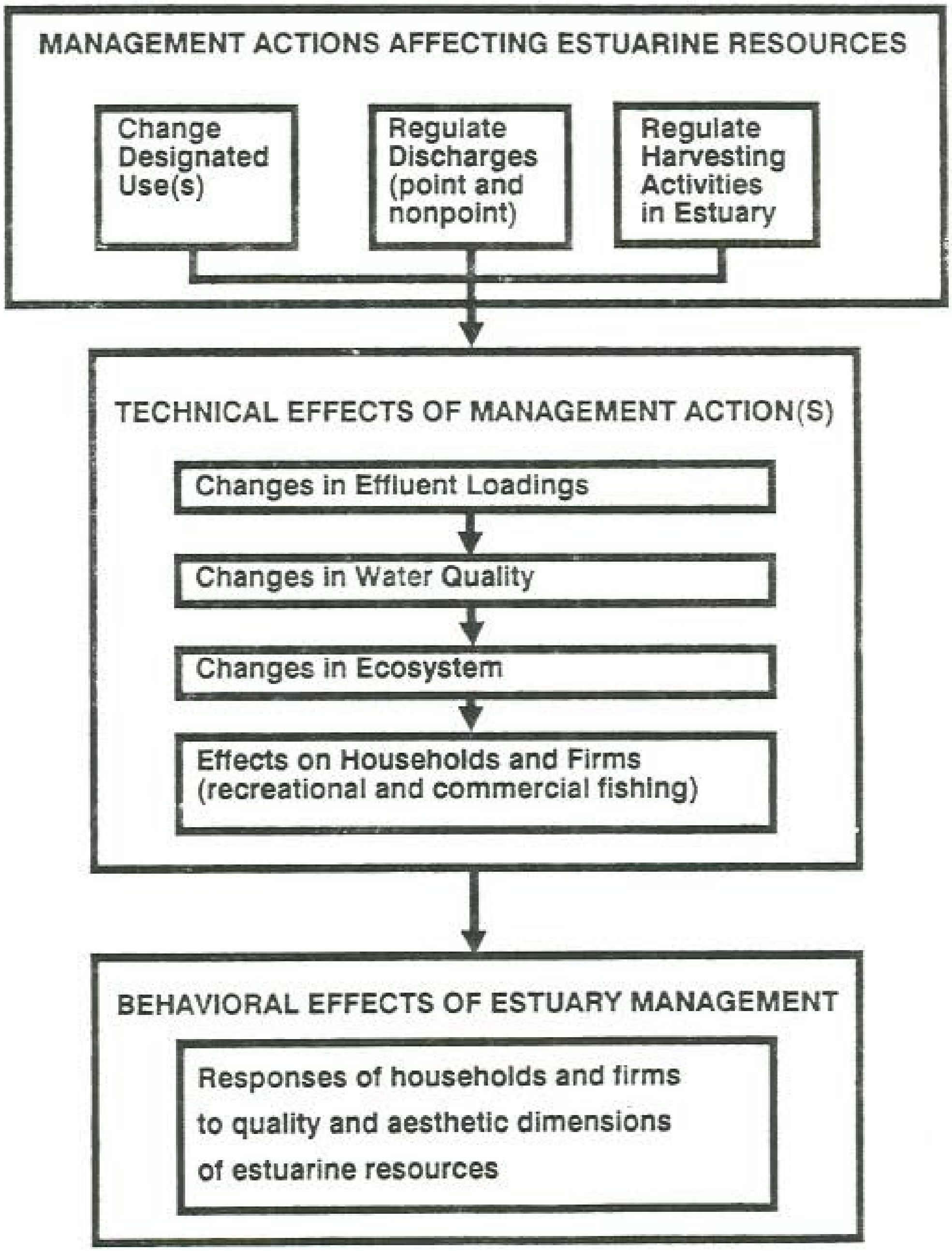
Moreover, within the category of use-related services, most estuaries support a wide range of activities as well as other complementary natural resources (e.g. wildlife resources). Benefit estimates should consider all of these contributions.

Connecting specific policy actions or elements in a management plan to measures of the benefits they ultimately yield is a complex process. Nonetheless, the connecting links cannot be treated in isolation from the economic models of how people respond to changes in the physical and aesthetic features of an estuary and the resources it supports. Figure 6.1 provides an overview of the process. Economic responses to the quality features of the sounds captured with travel cost demand models are the last component of the sequence of changes and are identified with the behavioral changes at the bottom of the figure. The full sequence begins with the plan and its implications for economic agents contributing to the effluent loadings, and their responses to any limitations it imposes on their activities, and works through the role of the natural system, converting changes in effluent loadings into changes in water quality and the other resources (e.g. fish populations) supported by the estuary.

In the absence of a full description of all the connecting links in this process, demand models cannot estimate the benefits of specific alternative elements of a management plan. Research for the Albemarle-Pamlico (AP) estuary is in the early stages of developing these elements. So at this stage, we cannot specifically connect our findings to a set of alternative proposals that might comprise the elements of a management plan. Indeed, even if these links

FIGURE 6.1

EFFECTS OF MANAGEMENT OF ESTUARINE RESOURCES



existed, we would not want to make such a connection now. Complementary research we have underway with the support of the North Carolina Sea Grant Program to evaluate the sensitivity of benefit estimates for improvements in the marine resources involved with sport-fishing indicates that the benefit estimates derived for comparably defined improvements in the Albemarle-Pamlico estuary can span a fairly wide interval.[2] We need a more complete understanding of the sources of these differences before selecting a "best" methodology and set of estimates for policy purposes. This is clearly the next step in this research. Nonetheless, it is possible to illustrate the types of evaluations that can be undertaken using the models described in Chapter 5. This is the purpose of this chapter.

Section 6.2 describes the benefit measure we use and its relationship to the Bockstael-McConnell [1987] analysis discussed in Chapter 5. In the third section, we describe the benefit estimates for several different hypothesized changes in the quality of the estuary, as represented by our measure of fish availability. Section 6.4 presents some results from a survey of recreationists using the area that we undertook in 1987 with the cooperation of the North Carolina Division of Marine Fisheries to learn if fishermen's responses to improvements in fishing conditions were consistent with the maintained assumptions of our models. Section 6.5 summarizes the chapter.

6.2 Valuing Improvements in Marine Recreational Opportunities

As we discussed in Chapter 5, Bockstael and McConnell [1987] have developed a general analysis and summary of benefit measures for quality changes. Building on Willig's [1978] earlier analysis, they demonstrate that when quality and another commodity (with an observable demand) are weak complements, when that commodity is nonessential, and when the quality-induced change in consumer surplus averaged over the quantity of the commodity involved is independent of income, then the change in Marshallian consumer surplus measures an individual's monetary value of the quality change.[3]

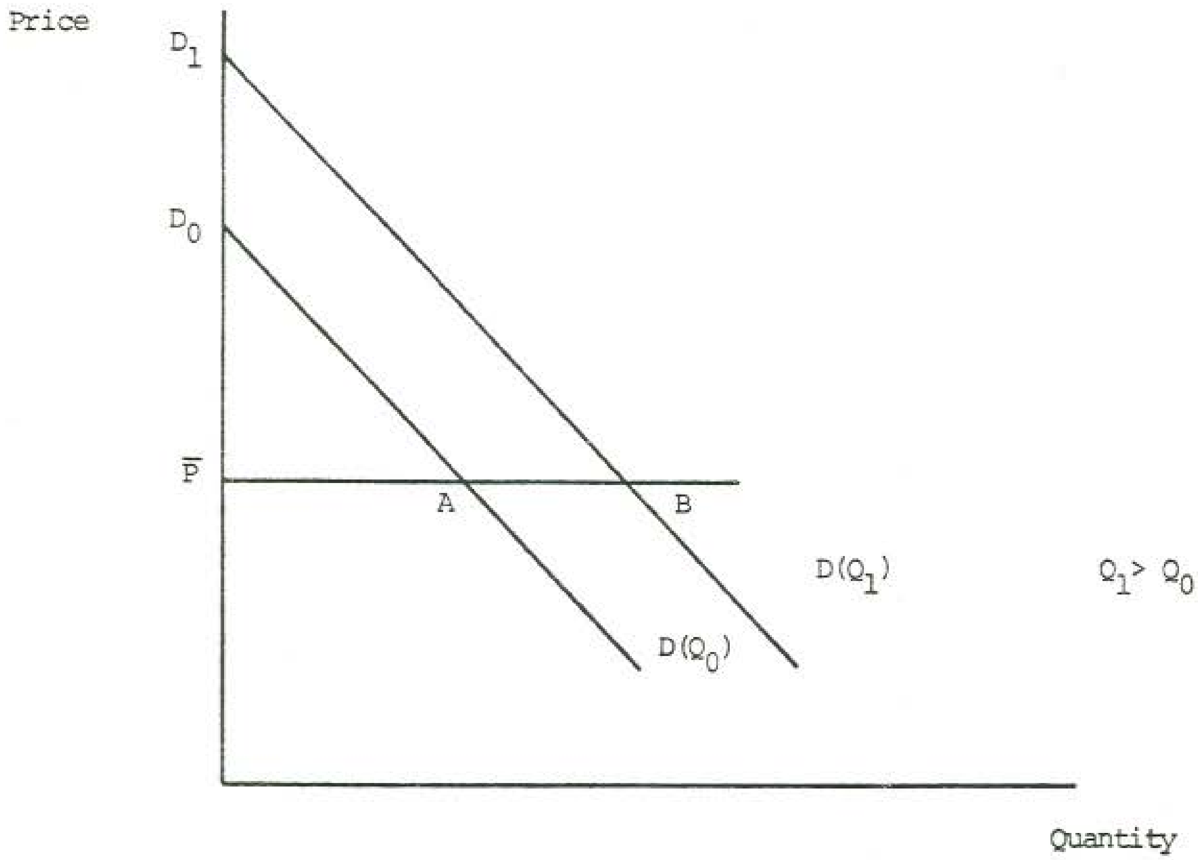
We can illustrate the task involved in developing measures of the quality-induced change in consumer surplus with linear demand schedules. Implementing this logic with a semi-log specification raises some questions that we discuss below.

Figure 6.2 illustrates the linear demand case for trips to a recreation site supporting marine fishing. The implicit price of a trip for a particular individual might be $\bar{P}$. When quality improves from Q_0 to Q_1, as might be the case with improved fishing opportunities or enhanced catch for a given amount of effort, then the individual's demand shifts out from $D_0D(Q_0)$ to $D_1D(Q_1)$. For the same price $\bar{P}$ (e.g. vehicle-related and time costs of travel), an individual now can use a fish site where he expects to realize greater enjoyment of his fishing because of the enhancement in the quality of the site. This is represented by the area D_0D_1BA. Under Bockstael and McConnell's assumptions, this area will be a monetary measure of what fishermen would be willing to pay for the specified improvements in fishing quality (i.e. from Q_0 to Q_1). It is a use-related benefit. The assumptions of their analysis have ruled out nonuse for these fishermen. If we interpret this as a full benefit, then we also eliminate any other nonseparable, use-related reasons for valuing site quality improvements.

Of course, to measure this area we must be able to observe how individuals have responded to changes in site quality over the relevant range for the policies under review. This is the primary advantage of our pooling the

FIGURE 6.2

Effects of Fishing Quality on Demand for a Sport-Fishing Site



records of respondents to the Sea Grant survey over entry points. That is, we sought to determine whether the variation in existing conditions across launch points could explain variations in demand in a format consistent with what we would expect on theoretical grounds. The situation is not as simple with a semi-log specification. This formulation does not have a finite choke price, in contrast to the graph in figure 6.2. Moreover, the graphical analysis assumes we observe both sufficient quality variation and those recreationists who would not come at the "prices" they face. We cannot fully resolve all of the issues raised by the limitations in our data. Nonetheless, on those questions associated with the range of variation in our quality measures and the numbers of trips taken by our sample respondents, both indicate that these concerns may not be especially important for our particular application. Our quality measure is based on the average experience of recreationists (boat fishermen) using each entry point in the Sea Grant survey. It ranges from .44 to 5.67 total fish caught per hour per person for Outer Banks entry points and from 0 to 6.8 for those in our Pamlico composite site.

As we noted earlier, the recreation sites comprising the Albemarle-Pamlico estuary primarily support local recreation. Most individuals do not travel more than 200 miles each way to access the sounds. Many are much closer. This pattern is consistent with the high numbers of trips that are reported for fishing each year.[4] As we discussed in Chapter 4, the average for boat fishermen using the Outer Banks sites was 29.7 and that for the Pamlico was 33.3. This would suggest that our inability to observe individuals who are "marginal participants" may not be important to our description of the demands for the average recreationist using the area. Moreover, it has been possible to gauge the importance of this using a maximum likelihood estimator and to recast the benefit measurement task in a format that overcomes some of the limitations of the semi-log specification. While these considerations support the general arguments underlying our model, it is important to recall our concern over the way the total quantity question was asked in the Sea Grant survey. We have assumed that the trips reported by our respondents were sport-fishing and the same as the trip when they were interviewed. We will never know whether this assumption is correct. These high levels for mean trips could also be a reflection that respondents included all trips in their responses, not simply those for marine recreational fishing at the same launch points. Because of this limitation, an important component of future work with this survey will require evaluation of individuals' valuations with models less dependent on this interpretation of the total use question. As we report in Appendix 7, several different functional forms were considered for our demand models. All of the benefit estimates reported here focus on models specified consistent with our preferred format--a semi-log using the log of trips as the dependent variable.

The semi-log form has remained popular with travel cost demand models because it seems to fit the demand patterns found with on-site surveys at the micro level. Moreover, it also leads to a convenient relationship to the Marshallian consumer surplus. If we assume a simple demand function as in equation (1) and ignore the role of substitute sites' prices and demographic variables:

$$\ln(V) = \alpha_0 - \alpha_1 TC + \alpha_2 Y \qquad (1)$$

With V = trips to a recreation site

TC = travel cost (round trip)

Y = income

then the consumer surplus (CS) is given as:

$$CS = \int_{\overline{TC}}^{\infty} \exp\ (\alpha_0 - \alpha_1 TC + \alpha_2 Y)\ dTC \qquad (2)$$

The upper bound or choke price is expressed as infinite (∞) because there is no finite price that will lead to zero trips with this specification. As we noted in Chapter 5, there is no specification for a utility function that would allow us to analytically derive the semi-log demand model. Rather, it is regarded as an approximation. In using this format, we make a number of simplifying assumptions. One of the most important of these from the perspective of its influence on estimates of consumer surplus (see Smith and Kaoru [1989]) is that we assume the time costs of travel can be treated as a parameter to the decision process, so TC is also a parameter. As we developed in Chapter 2, there are a variety of reasons for concern about how we deal with the opportunity costs of time. We have selected the wage rate and investigated the sensitivity of our demand models to this specification. Development of a detailed model of the decision process, where time costs were treated as endogenous, is beyond the scope of this research.

Given these caveats, we treat TC as a parameter to the consumer's decision process and derive the simple concept of consumer surplus from the estimated travel cost demand function. The solution to equation (2) is given in (3):

$$CS = - \frac{1}{\alpha_1} \exp\ (\alpha_0 - \alpha_1 TC + \alpha_2 Y) \Big]_{\overline{TC}}^{\infty} \qquad (3)$$

or

$$CS = \frac{1}{\alpha_1} \exp\ (\alpha_0 - \alpha_1 \overline{TC} + \alpha_2 Y) \qquad (4)$$

But exp $(\alpha_0 - \alpha_1\overline{TC} + \alpha_2 Y)$ is simply the number of trips that would be taken (the quantity demanded) at a price of $\overline{TC}$ for a person with Y income. Thus the absolute magnitude of the inverse of the coefficient for the price measures consumer surplus per trip.

We have used the relationship to calculate the value of a quality change under the Bockstael-McConnell assumptions. In our model, each entry point will lead to differences in individuals' demand because of the differences in quality. To illustrate how this affects our analysis, equation (1) must be replaced by (5):

$$\ln(V) = a_0 - a_1 TC + a_2 Y + a_3 TC*CR \qquad (5)$$

where CR = the average catch rate for each specific entry point

Thus, for measuring consumer surplus per trip, the effect equivalent to α_1 is $a_1 - a_3 CR$. To measure the area D_0D_1BA in figure 6.2 with our model, we propose to compute the consumer surplus increment on a per trip basis. As a result, we are implicitly scaling the two areas in figure 6.2 by different numbers of trips and adjusting for the increased quantity demanded with enhanced quality (and constant prices). Because the model has not been developed to forecast aggregate trips, this format is the most flexible. It allows approximate aggregate benefit measures to be developed by using it with others' estimates of incremental use of the area. Thus, the consumer surplus per trip for improvements in quality from CR_0 to CR_1 is given by equation (6):

$$\Delta CS(\Delta CR) = \frac{1}{(a_1 - a_3 CR_1)} - \frac{1}{(a_1 - a_3 CR_0)} \qquad (6)$$

where $\Delta CR = CR_1 - CR_0$

Our ability to observe demand responses to quality variation was resolved by pooling respondents across entry points. As we observed in Chapter 5, this framework can be treated as either a varying parameter model or a form of regional travel cost demand. What is important for our purpose is observing sufficient variation in quality across entry points to detect an effect and to span the range of feasible policy initiatives. On the first aspect of this requirement, we seem to have sufficient variation to detect effects. For the second aspect, we are more cautious. Our information is crude and limited for the highest quality ranges. Moreover, in the last chapter we indicated that our estimates of the size of the consumer surplus per trip seemed quite high in relationship to both past literature and the travel costs. Moreover, we observed rather large changes in consumer surplus per trip as we used the model for entry points with very high levels of quality in each site composite.

6.3 Benefit Estimates for Hypothetical Quality Improvements

The structure of our demand models allows a variety of benefit analyses for each of our composite sites. The first class of these analyses considers postulated changes in our quality measure that are described as modifications for specific entry points. For example, we consider a 25 percent improvement in fish availability at a specific site. We examine the gains from improving conditions at the worst site (in terms of average catch rate) to the average of all catch rates for all entry points in the composite site. In each of these cases, we are suggesting potential improvements without attempting to determine whether policies could actually yield these changes. To answer this question requires that we fill in the top panels of Figure 6.1. This is beyond the scope of our research.

In order to illustrate how this distinction between postulating an improvement in fishing opportunities versus a reduction in effluents is important, we used the information collected on effluent loadings in areas close to the recreationists' launch points to evaluate whether these pollution measures were related to the catch rates. More specifically, with the average catch rates and pollution loadings for each 35 launch points, we investigated whether a consistent statistical relationship existed between the catch rate and one or more of the measures of effluent loadings.[5]

The results were limited, largely because of high collinearity and the crude nature of the assignment assumptions used to match the effluent loadings to launch points. Nonetheless, one simple equation illustrates the type of linkage needed to implement a valuation analysis in support of these types of policies:

$$CR = \underset{(7.73)}{3.425} - \underset{(-1.628)}{.246\text{x}10^{-2}}\ Phos \qquad R^2 = .074 \tag{7}$$

where CR = catch rate - the average of total fish catch per person per hour at each launch point

Phos = estimates of aggregate discharge (for point and nonpoint sources) of phosphorus from coastal counties (in tons per year)

The numbers in parentheses below the estimated coefficients are the t-ratios for the null hypothesis of no association.

By using this simple equation, we can illustrate the difference between expressing scenarios in terms of reducing effluent loadings versus in terms of improving catch rates. This equation is <u>not</u> intended to be a predictive relationship. Rather it is an illustration of the importance of the natural science information required to "fill-in" the middle of Figure 6.1 for developing benefit analyses as an integral component of relating policy to outcomes in a management plan for the estuary.

Table 6.1 reports the results of each of these types of scenarios for the Outer Banks composite site. Table 6.2 reports comparable results for the Pamlico site. Two models were used for the Outer Banks estimates - the full sample estimate for the demand function and one restricted to those respondents within 200 miles (one way) of these sites. The specific equations are those from columns 2 and 4 of Table 5.4. They correspond to the truncated maximum likelihood estimates. Both tables report the estimated increment to consumer surplus per trip for each specified quality improvement. They are expressed in 1981 dollars.

As we discussed in Chapter 5, the model using recreationists within 200 miles of the launch points for the Outer Banks yields smaller estimates of the gain. Comparing the benefit estimates for improvements defined based on reductions in pollution loadings versus catch improvements, even in the case of linear models linking the two, illustrates the importance of understanding the connecting links between policy and outcomes perceptible to recreationists.

Table 6.2 repeats scenarios for launch points in the Pamlico composite site. Because all recreationists were from within 200 miles, we considered only the demand estimates from the full sample using the function reported in Table 5.5, column 2. These estimates are generally smaller than those for the Outer Banks. Taken together, the two sets of results illustrate how differences in the base level of quality of a fishing area will lead to differences in the estimates of the benefits from improvements. To illustrate

TABLE 6.1

Consumer Surplus per Fisherman per Trip for Quality Enhancements: Outer Banks Sites

Scenario	Model: Full Sample	Model: Within 200 Miles
Overall Improvements		
1. 25% increase in catch rate from area average	$ 70.95	$ 24.15
2. 25% decrease in phosphorus loadings from Albemarle-Pamlico average	$ 60.06	$ 20.61
Targeted Improvements		
1. 25% increase in catch rate at the entry point with the lowest catch rate (catch rate = .44)	$ 4.46	$ 1.75
2. Improve catch rate at worst site to average	$131.47	$ 48.95
3. 25% increase in catch rate at most frequently visited site in sample	$ 67.55	$ 23.17
4. Reduce phosphorus loadings from highest levels in the area by 25%	$ 3.86	$ 1.27

TABLE 6.2

Consumer Surplus for Quality Enhancements: Pamlico Site

Scenario	Full Sample
Overall Improvements	
1. 25% increase in catch rate from area average	$ 9.39
2. 25% decrease in phosphorus loadings from Albemarle-Pamlico average	$ 2.46
Targeted Improvements	
1. 25% increase in catch rate at the entry point with the lowest nonzero catch rate (1.0)	$ 1.99
2. Improve catch rate at worst site (1.0) to area average	$18.66
3. 25% increase in catch rate at most frequently visited site in sample	$ 3.31
4. Reduce phosphorus loadings from highest level in the area by 25%	$ 3.56

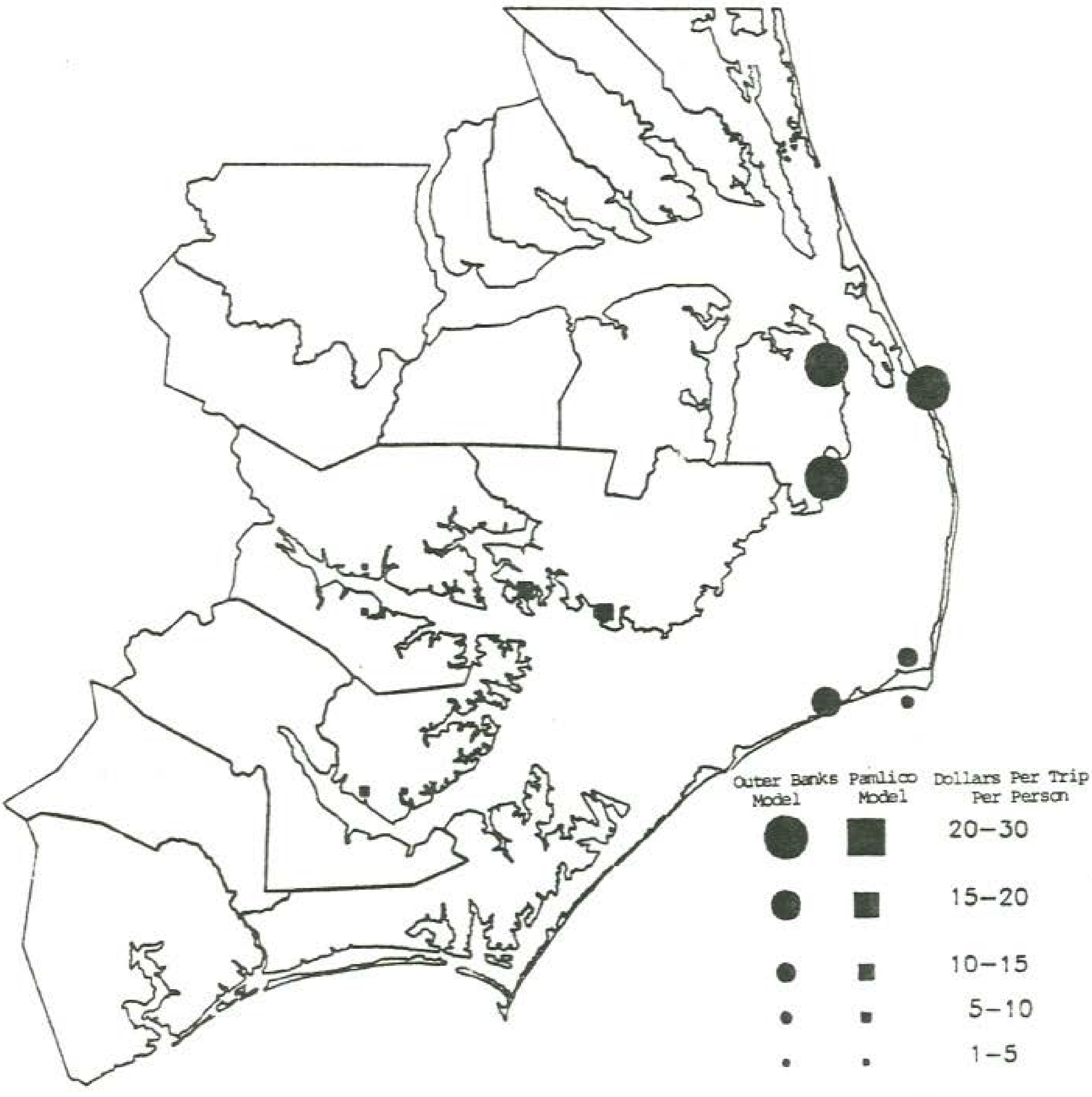
this point, we computed the consumer surplus gain for a 25 percent increase in the catch rate for all launch points in both composite sites. Figure 6.3 plots the estimated consumer surplus gain per trip at selected locations.

There are several important caveats to be recognized in interpreting these results. First, they are based on patterns of use given an existing distribution of quality levels for the areas adjoining entry points into the Sounds. Large changes in this distribution will change the patterns of use and the underlying magnitude of the values for further improvements in quality of specific locations. Second, specifying models that took into account the effects of substitute sites was quite important to our estimates of demand functions. This was especially true in the case of the Pamlico demand function. This should not be surprising for this type of recreation. The launch points we have used to define composite sites are simply the entry points individuals use to access the larger site. While we attempted to reduce the influence of overlap in the structure of our overall definitions of composite sites, we expect that benefit estimates will be sensitive to how these substitution effects are treated. Preliminary research using a random utility model to describe individuals' demands for access to locations within this area based on these same data and different definitions for the sites being chosen supports this conclusion.[6]

Finally, our estimates are values per trip per person. To develop estimates that gauge the benefits (arising from marine recreational fishing) from improvements in quality, we also need to consider the effects of the quality change on the number of trips a typical person will take and the number of additional people who may also use each site. Our model considers the first of these. Resolving the second consistently is, as Bockstael et al. [1988]

FIGURE 6.3

Geographic Distribution of Values of a
Twenty-five Percent Improvement in Catch Rates



have acknowledged, more difficult. Clearly, both issues will need to be considered in the development of aggregate benefit estimates for quality improvements.

6.4 Contingent Behavior Responses as a Check on our Description of Quality Changes

Our analysis of quality differences in the fishing opportunities in the Albemarle-Pamlico Sounds has relied on some strong assumptions about individuals' knowledge and fishing behavior. We have assumed that people evaluate the quality of sport-fishing sites based on the relative availability of any type of fish, and that their perceptions of the fishing quality adjoining launch points corresponds approximately to the average catch rates of boat fishermen using those sites during the same season. Our model uses the variation in selections of launch points for given travel costs together with the variations in average catch rates to infer how fishermen's relative propensity to use higher quality sites affects their responsiveness to implicit trip prices.

One way to gauge whether these assumptions are plausible would involve interviewing fishermen to determine how they indicate they would change their recreation patterns in response to quality improvements. This type of interview focuses on what has been described as contingent behavior, or individuals' responses to hypothetical situations. This method has been used to value improvements in freshwater sites (see Ribaudo and Epp [1984]) and has been used in a number of other types of applications (see Smith and Desvousges [1986b]).

With the cooperation of the North Carolina Division of Marine Fisheries, questionnaires were randomly distributed to fishermen interviewed as part of the Division of Marine Fisheries/National Marine Fisheries Service intercept survey. Over 400 of approximately 1,200 questionnaires distributed during the in-person interviews were mailed back to us. Table 6.3 reproduces the questions used to estimate how behavior would respond to quality changes. Table 6.4 provides a summary of the preliminary results for those questions on responses of planned trips to each of three different increments in catch rates.

The research design for this supplement to the NMFS survey relies on obtaining information about the respondent's travel costs and fishing experience from that interview. It was intended to supplement these data with responses to the contingent questions. Our design involved six different questionnaires with three variations in the catch rate (10, 25, and 50 percent increases) and with two other aspects of estuarine quality, one associated with eliminating red sore disease and a second associated with eliminating algae blooms. Each respondent was asked about his (or her) responses in terms of future trips after one proposed catch increase and a comparable question about either red sore disease or algae blooms. Thus, there were six different subsamples.

When these data are merged with the NMFS survey interviews, we will have sufficient information to estimate travel cost demand functions reflecting for actual behavior and contingent behavior. However, this requires the two sets of data to be merged consistently and is beyond the scope of the current research.

TABLE 6.3

Contingent Behavior Questions for Fishing Quality Improvements

I. Base level of Fishing Activity Question

How many fishing trips have you made in the last 12 months?

II. Catch Improvement Question

Based on your experience in the last 12 months, how many fish of your target species for this trip do you think you will catch each day (on average)?

	Type of Fish	Quantity of Fish	
#1	_______	________	(number of fish ____or lbs____) (check one)
#2	_______	________	(number of fish ____or lbs____) (check one)

Suppose by reducing pollution you could catch 50% more fish each day of your first target species. How many trips do you think you would take in the next 12 months? In answering, suppose also that catch rates for other species would not change, and that your costs for a fishing trip would not change.

________trips

III. Red Sore Disease Question

a. Has the presence of red sore disease caused you to throw back fish caught on recent fishing trips? yes_____ no_____

b. If yes, about how many fish had to be thrown back because of red sore disease in a typical trip? ____ (fish___ or lbs___)

c. Suppose that by reducing pollution red sore disease could be eliminated, but now assume that your expected catch rates would remain at their current levels. How many fishing trips would you make in the next 12 months? _____trips

IV. Algae Bloom Question

Suppose that reducing pollution could eliminate algae blooms, but now assume that your expected catch rates would remain at their current levels. How many fishing trips would you make in the next 12 months if algae blooms were eliminated? ______trips

TABLE 6.4

Fishing Trips and Improvements in Catch Rates: Mean Values[a]

Sample Subset	Sample Size	Improvement in Catch Rate (Percent)	Normal Fishing Trips	Fishing Trips Under Improved Catch Conditions	Fishing Trips Eliminate Red Sore Disease	Fishing Trips Eliminate Algae Blooms
A1	51	10	26.7	29.4	---	25.1
A2	61	25	22.3	27.2	---	28.3
A3	73	50	18.6	23.7	---	21.0
B4	38	10	16.8	23.0	24.0	---
B5	56	25	14.6	19.9	11.6	---
B6	46	50	13.8	15.3	14.9	---

[a]The A samples correspond to individuals asked about their increases in fishing trips with elimination of algae blooms in addition to one of the three catch rate improvements. The B samples were asked about red sore disease in addition to the catch rate improvement question.

Nonetheless, at this stage, we do have clear evidence of an increase in proposed trips for most of the subsamples, even without taking account of differences in the travel costs (and other characteristics) across respondents. Thus, even with fairly crude summary data, recreationists' responses to improved catch rates (their stated intentions for increases in fishing rips) are consistent with the responses hypothesized by our model.

6.5 Summary

This chapter has described how the travel cost demand models developed for the Outer Banks and Pamlico composite sites can be used to estimate the benefits arising from improvements in the quality of the estuary. Because the focus of our analysis has been sport-fishing, the primary aspect of quality we attempted to evaluate is the availability of fish at different locations in the estuary. The models allow differences in the base level of quality to affect our measures of the value of fishing trips to each of these sites, as well as that value changes with improvements in quality. They illustrate the importance of the connections linking the variables that can be influenced by policy to the measures for quality perceived by recreationists.

Based on the more conservative of the models estimated from the Outer Banks composite site, the per person per trip benefits of a 25 percent improvement in the catch rate range from about $2.00 to $38.00 for most sites.[7] Values are generally lower for the Pamlico composite site, ranging from $2.00 to $14.00 per person per trip for the same 25 percent increment in catch rates.

Differences in these benefit estimates across launch points reflect differences in the level of the catch rates at each location. Those observed across the two composite sites arise from other differences in the characteristics of the sites involved.

Overall, these estimates provide support for the basic modeling framework and illustrate that with refinement, it may have substantial value to the evaluation of policy options in an overall management plan for the Albemarle-Pamlico Estuary.

Chapter 6

FOOTNOTES

1. At present, the only method available for measuring nonuse values is through the use of survey techniques - asking individuals' valuations for changes in the amount or quality of resources in ways that allow their motives to be distinguished. For a discussion of the conceptual issues involved in defining nonuse values, see Smith [1987]. Fisher and Raucher [1984] provide a summary of some of the early literature on the relationship between use and nonuse values for water quality improvements.

2. See Kaoru [1988] for discussion of the preliminary estimates developed using a random utility model with these same data.

3. Thus, their assumptions are sufficient to assure that the Marshallian measure corresponds to the theoretically desirable Hicksian measure of the values of a quality change.

4. If the Smith-Kopp [1980] argument that the assumptions of the simple travel cost model become progressively more questionable with the distance between the origin point and the site, this pattern of use implies the model should provide an adequate description of behavior.

5. A large number of alternative specifications were considered with variations in the pollution measures and the catch measure. Significant positive and negative coefficients were found for pollution loading estimates as influences on fishing quality. As a rule, the significant positive coefficients were unstable, changing with alterations in the specification. However, the record for a negative relationship is not stronger. Negative effects were also sensitive to the other pollution variables included in the model, as well as the catch measure used. For these reasons, we describe this relationship as illustrative of the effects of the physical linkages and not as a basis for policy decisions.

6. See Kaoru [1989]. This study was undertaken as part of the research associated with the North Carolina Sea Grant project in this area.

7. In developing these ranges, we deleted the largest values for both the Outer Banks and Pamlico sites. They are associated with largest catch rates, and increases of 25 percent are substantially beyond the range of sample experience.

Chapter 7

Conclusions and Directions for Future Research

7.1 Conclusions

Recreational fishing is one of the most important uses of the Albemarle and Pamlico Sounds, yet fishing activity can be severely affected by effluents entering the sounds from upstream and adjoining activities. One of the primary goals of the Albemarle-Pamlico Estuarine Study is to develop a management plan to preserve and enhance the quality of the sounds. Such a plan must necessarily consider the value of the potential enhancements that can result from various policies to restrict the introduction of effluents into the sounds. Unfortunately, the value of recreational fishing is more difficult to determine than is the value of activities such as commercial fishing where markets provide valuation information. Nonetheless, the value of recreational fishing and related activities will have to play a significant role in the decision-making process that will evolve in the Estuarine Study.

The research effort described in this report, which is part of a more extensive on-going research program, has sought to determine the value of recreational fishing and improvements in fishing opportunities to fishermen. Because of the rich variety that exists in the sounds, a new modeling strategy was necessary. While our model for this project has its roots in the traditional travel cost demand models, it differs in various ways. The significant differences in the characteristics of the two sounds led us to treat them as different aggregate sites. Similarly, launch points on the Outer Banks also provide a different type of experience. Thus we had three composite sites: Outer Banks, Pamlico, and Albemarle. Within these composite sites there were differences depending on the specific launch site that was used.

The most important difference for our purposes was in catch rates, which differed across the launch points comprising each of the three destinations. This enabled us to study the effects of expected catch rates on recreationists' decisions to fish on the sounds and to incorporate substitution possibilities across these destinations.

The models selected as our final specifications explained the number of trips taken using the travel costs (including both vehicle and time costs) involved in the trip to the site visited, the expected catch rate interacted with travel costs, similar measures of the costs of trips to the substitute sites, and various socioeconomic variables including income. We have shown that this specification could be derived from several alternative conceptual models of individuals' recreation decisions. These include: a model where fishing quality was a translating variable in the fishermen's utility function or a framework allowing the travel cost coefficient to vary with catch rate within each of the three composite sites while also allowing for substitution opportunities between sites.

Using this specification, our estimates considered four different samples: Outer Banks full sample, Outer Banks visits from within 200 miles, Pamlico full sample, and Albemarle full sample. For the mainland Pamlico and Albemarle launch sites nearly all visits were from within 200 miles, so subsamples based on the 200-mile distance threshold did not markedly affect our estimates. In contrast, the Outer Banks attract visitors from much greater distances. While the signs and significance in estimated parameters were comparable, there were differences in the magnitudes of coefficients between the two Outer Banks samples. The results were quite encouraging for three of the four samples, with the coefficients having the expected signs and significance and generally being robust with respect to varying the specification. A maximum likelihood estimator was also used with these specifications to evaluate the effects of correcting for the sample truncation. These results are presented in Tables 5.4 and 5.5.

The only sample where we did not have this success was for launch sites designated within the Albemarle destination. As a consequence, the benefit estimates are presented for Outer Banks full sample, Outer Banks within 200 miles, and Pamlico destinations.

The primary goal of the research program we have undertaken is to value activities such as recreational fishing. In the current research we have used our estimated equations to estimate the value of a fishing trip and also to gauge the value of improvements in fishing quality. For example, for each sample the value of the fishing trip above what the individual implicitly paid in travel costs (including vehicle and time costs) was calculated for an average trip to that area. For the mainland Pamlico sites this value was $102.71, and for the more local visitors to the Outer Banks the value was $163.02. When more distant visitors were included in the sample, the value rose substantially to $385.98.

A second aspect of these models concerns their ability to estimate the value of quality improvements. This feature has the potential for being of substantial interest for the Albemarle-Pamlico Estuarine Study. These estimates were developed first for an overall improvement in the average catch rate for sites within a composite destination. Using the full sample for the Outer Banks, a 25 percent improvement in catch rate from the area average would be valued at $70.95 per fisherman per trip, whereas a 25 percent decrease in phosphorous loadings would be valued at $60.06. These values may be high.

When the sample was limited to within 200 miles, these estimates were reduced to $24.15 and $20.61 respectively. While the reduced estimates seem more plausible, it is important to recognize that the scenario definitions determine the magnitude of the changes involved. With reductions in effluent loading, these changes are translated into catch rate changes using the simple regression models we developed to illustrate the importance of these biological linkages. For the Pamlico, these two values for overall improvements were $9.39 and $2.46 respectively. These lower figures seem appropriate because of the differences in the visitors and type of experience.

Sample calculations also have been provided for targeted improvements to specific launch points within each composite destination. For example, improving the catch rate by 25 percent at the most frequently visited entry point in each area would be valued at $67.55, $23.17, and $3.31 for the Outer Banks full sample, the Outer Banks within 200 miles, and the Pamlico samples respectively. Similarly, improving the catch rate at the worst site to the area average, a considerably larger improvement, would be worth $131.47, $48.95, and $18.66 for each of the samples respectively. Further examples are given in Tables 6.1 and 6.2.

These results are encouraging. The models that we developed provide one explanation for the decision process of fishermen in this area. Our estimates provide, in most instances, plausible results. Nonetheless, it is important to recognize that our analysis has focused on one type of model - a conventional travel cost demand framework. In the next section we discuss other alternative modeling frameworks and means to reconcile any differences in the estimates with these alternative techniques. A synthesis of the results obtained using these various techniques will provide the most defensible estimates of the value of improvements to the quality of the Albemarle and Pamlico Sounds.

7.2 New Research Initiatives

The research objectives of this project have been met and in at least one respect exceeded. When we proposed the research, it was not clear that we would be able to describe the North Carolina Sea Grant survey respondents' recreational decisions within a travel cost framework. Our primary concern was with the interpretation we had to give to the fishing trips question in order to implement the model. As we observed in Chapter 4, even though the context of the interview was sport-fishing in the Albemarle and Pamlico Sounds, the question did not specifically ask about trips to the entry point of the interview or, indeed, to any other part of the sounds. It simply asked about fishing trips without further specification. Our models have maintained that the responses were good indicators of the use of the sounds. While this is a potentially important limitation, the results are consistent with the assumption. They do support a theoretically plausible, negative relationship between the implicit price of a trip and the number of trips taken during a season. Moreover, they also indicate that our measure of quality - the average catch rate - does affect demand in two of the three areas we identified as "sites" for demand modeling.

Because of the this finding, it was possible to illustrate how this type of model would be used to estimate the benefits a typical recreationist would realize from improvements in the quality in different locations in the estuary. These estimates are intended to be illustrative only. They demonstrate how this degree of resolution in understanding the factors influencing peoples' demands for sport fishing can provide information on one component of an improved estuary.

Two classes of research issues have been identified from our analysis. The first of these involves questions that are more methodological and have a somewhat longer term, academic orientation. They arise from the need to reconsider an important simplification in most recreation demand analysis. By adopting a partial equilibrium orientation, most conventional recreational demand models have abstracted from several types of interconnections in an individual's decisions between the acquisition and use of fishing gear, a fishing boat, and the allocation of the amount of time, as well as the time horizon for all of these decisions.

The second group of issues focuses on the next steps to convert models that to date offer promising, but preliminary, benefit estimates into models for benefit estimation that are reliable enough to become components in a comprehensive conservation and management plan. Such a plan must be capable of analyzing the tradeoffs in policy choices and thereby prioritizing actions to improve the estuary. Because the Albemarle-Pamlico Estuarine Study is intended to develop research that supports such plans, this second group will be the focus of our discussion of new research initiatives.

We have divided our proposals for new management-related research that will address the benefits arising from the goals to improve the estuary into four areas:

(1) finalizing a modeling structure for estimating the benefits to recreational fishing from improvements in estuarine quality;

(2) evaluating how fishermen, as well as other recreationists, perceive

the quality attributes of the estuary and how those perceptions influence their patterns of use;

(3) developing economic demand models for other recreational and nonrecreation uses of the estuary; and

(4) measuring the extent of nonuse values arising from enhancement of the estuary and the other resources and wildlife it supports.

We will consider briefly some of the key elements in each of these areas below.

A. Finalizing a Model for Marine Fishing Benefits from Quality Enhancements

Our demand estimates use implicit prices arising from the need to travel to recreation sites to obtain these services. As we observed in Chapter 2, there are several different ways to use this insight, in addition to the formulation of a conventional demand model. Each approach makes somewhat different (and largely untestable) assumptions about how people make these decisions. To date, the literature has not developed a consensus on a best or most robust model. Indeed, Kling's experimental work (see Kling [1988] and Kling and Weinberg [forthcoming]) would suggest that the best approach will depend on the type of decisions being modeled.

Based on these findings, decisions involving local recreation sites where the substitutes available are important to the choices are likely to be described better using some variation on a random utility model. In contrast, when substitution is not as readily possible and the decisions are planned over longer time horizons, we might expect that the travel cost demand approach would be better. Of course, these are only qualitative assessments. What is important from a policy perspective is whether the modeling strategy matters to the benefit estimates needed to evaluate a particular class of policy decisions.

Answering these questions requires a comparative analysis of the available modeling strategies with the same data and a complete evaluation of their respective implications for the models' estimates. This effort is the second stage in our ongoing research program on the value of improving the quality of marine recreational fishing in the Albemarle-Pamlico Sounds. With support from the North Carolina Sea Grant Program, we are evaluating three modeling strategies in comparison with the conventional travel cost demand models. These models include: random utility models, logically sequenced or nested utility models, and hedonic travel cost models.

While this research is currently underway, a few of the preliminary findings provide a clear indication of the importance of these comparisons. Table 7.1 summarizes the estimates of per-trip, per person consumer surplus increments estimated from a random utility model and our conventional travel cost demand models. While the specific results available were not developed from perfectly compatible scenarios, the findings illustrate our basic point - evaluation of models for benefit analysis is an integral part of the determination of a "best" framework for policy analysis.

The differences between the random utility and Outer Banks' demand model estimates are quite large for some fairly similar scenarios. They are less pronounced for the Pamlico model. Much of the difference can be explained.[1] Moreover, the estimates could be converted into comparable terms for developing interval estimates or ranges for the benefits estimated to arise from quality improvements.

TABLE 7.1

Comparisons of Benefit Estimates
Across Modeling Strategies

Model	Incremental Consumer Surplus
Random Utility Model[a]	
1. Increase average catch rate at each site by 25%	$2.43
2. Increase catch rate at closest 4 sites to most respondents by 25%	$ .60
Conventional Travel Cost	
A. Outer Banks Model (<200 miles)	
1. Increase average catch rate by 25%	$24.15
2. Range of values for 25% improvement in catch rate across most sites	$1.74 - $38.07
B. Pamlico Model	
1. Increase average catch rate by 25%	$9.39
2. Range of values for 25% improvement in catch rate across most sites	$1.99 - $14.24

[a]These results are taken from an unpublished Ph.D. thesis that is being prepared as part of the research supported by the North Carolina Sea Grant project. See Kaoru [1989] for a summary.

Understanding the reasons for variations in a model's estimates so they can be reflected in how those results are used is an essential element in research designed to support policy analysis. Our planned activities with N.C. Sea Grant support were not intended to complete this process. Rather, they focus on developing the remaining modeling alternatives. Comparative evaluation and reconciliation of findings remain a separate set of tasks that are clear candidates for future research.

B. The Role of Quality in Other Uses of the Estuary

Most descriptions of the Albemarle-Pamlico Sounds identify recreational fishing as among the most important activities affected by deteriorations in estuarine quality. There are many others, and commercial fishing is certainly one of them. While commercial fishing can conflict with recreational uses of the fisheries supported by the estuary, given that commercial fishing is permitted at some level, then improvements will reduce costs for commercial fishing, and these should be taken into account in a comprehensive management plan.

The sounds also support other types of recreation that may well be influenced by their quality. The N. C. Sea Grant survey does not provide information to permit evaluation of any other types of recreation benefits. With data, these could be described similarly to the sport-fishing models.

Our literature review indicated that there was very little information in the literature that might assist here. Consequently, this area should be a high priority to complete the use-related recreation benefit measures for quality improvements.

C. Quality Perceptions

Our analysis has maintained that the catch rate is the most important quality feature of the estuary from the perspective of fishing activities. This approach is certainly consistent with the past literature. However, as we consider other types of recreation, the physical characteristics individuals use to form perceptions of estuarine quality are less clearcut. Nonetheless, understanding this process is essential to establishing a connection between the demands for uses of the area to support these other forms of recreation and any changes in the quality of the estuary.

Some research is currently underway on related issues for the Chesapeake Area. Thus, some learning from that experience is possible (see Bockstael et al. [1987, 1988]). However, the pronounced differences in the natural settings and circumstances of the two estuaries suggests that a parallel research effort on quality perceptions for the A/P program is warranted. This would use the findings of the Maryland effort as a starting point and assure the resolution in indexes of quality (or perceptions of quality) needed for the demand modeling associated with other recreational uses.

D. Nonuse Benefits

People value natural environments even though they may not actively use them in some form of outdoor recreation. Conceptual and empirical support for the importance of these values to resource management has grown since Krutilla [1967] first raised these concerns over twenty years ago.

Nonetheless, the empirical evidence with estimates of the magnitude of nonuse benefits remains limited. There are good reasons to assume that these values will be even more specialized and less transferrable between resources, and therefore more specific to individual resources than use-related values (see Smith [1987]).

Survey techniques remain the only method for measuring the size of these values. Because they may well be especially important to aesthetic dimensions of the estuarine and the conservation dimensions of a comprehensive management plan, efforts to measure them should be given high priority.

7.3 Summary

This chapter has provided an overview of our findings and the new research issues that emerge from them. Our specific focus has been on questions relevant to the needs of a comprehensive conservation and management plan for the Albemarle-Pamlico Estuary.

The research to date has clearly established the feasibility of quantifying the benefits from management programs for one of the important recreational activities for the estuary. What remains to be done involves extending this type of analysis to include all of the activities enhanced through improvements in the estuary.

Chapter 7

FOOTNOTES

1. These differences have several explanations. First, the decision process envisioned in the random utility model (RUM) implies we should expect the travel cost model to be larger than the RUM estimates. Within a RUM model, recreationists are assumed to make each trip decision as an independent choice, one that is not affected by past or planned future choices. This leads to a somewhat different interpretation of the valuation concept.

Second, the scenarios are somewhat different. The scenario for the RUM model increases all launch points' catch rates by 25 percent, so the average would increase by that amount. This same phenomenon is represented with the travel cost model by assuming all launch points are at the average catch rate and it increases by 25 percent. The two are not the same. The former maintains the relative diversity in launch points' quality; the latter does not.

Third, and finally, the RUM scenarios allow for a simultaneous improvement in quality at substitute entry points outside those in the Outer Banks launch points (or for comparison with Pamlico results, Pamlico entry points). The travel cost models do not.

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Appendix 1

Predicted Wage Methodology

The purpose of this appendix is to describe the method used to estimate the opportunity cost of travel time. This cost is one of the largest components of the travel cost. In contrast to other components of the travel cost, such as the vehicle operating cost per mile or the fees to enter a site, the time costs of travel can be quite variable. As Chapter 2 described, several methods have been used in the literature. We considered three methods in our analysis. The first involves using the family income reported by each person per estimated potential hour that could be worked in a year, implicitly assuming all income arises from the earnings of the specific recreationists. The presence of nonwage income and multiple-earner households is usually not capable of being accommodated in this approach.

The second approach uses a model describing how an individual's hourly earnings would be affected by personal characteristics, job characteristics, and site amenities to impute a wage rate for each person. The third uses a fixed fraction of the wage following Cesario and Knetsch's [1971] early arguments that these time intervals do generate utility.

This appendix describes the specific details underlying the construction of these predicted wage rates. To gauge the plausibility of these imputations, the appendix provides some comparative evidence on the wage rates predicted for our sample of recreationists in relation to their demographic characteristics and occupations. We also compare the predicted wages with the estimates using total income per hour.

Predicted Wage Model

Wage rate estimates were based on a hedonic wage model estimated by Smith (1983) based on the 1978 Current Population Survey. Wages were modeled as a function of individual worker, job, and site characteristics. The sample was based on interviews conducted in May. When the wage and other job information was merged with separate information on job and site characteristics, a sample with respondents from a total of 44 SMSA's was composed. Site characteristics included climatic, cultural, and amenity variables. Job characteristics included qualitative features of the jobs, as well as estimates of risk of accident or death.

In using the hedonic wage model for the Albemarle-Pamlico respondents, some modifications had to be made. Information for several of the job and site characteristics used in the hedonic wage model simply was not available in the Albemarle-Pamlico data set. The variables included veterans' status, injury rates on the job, cancer exposure, air pollution, unemployment rates, union membership, on-the-job training, crime rate, sunshine, and whether the respondent was a head of household or a dual job holder. Consequently, mean values for each of these variables from the original survey were assigned to these variables.

Other data collected in the study area had to be slightly modified for use in the wage model. The original survey classified occupations on a much more detailed basis than necessary for the wage model. Occupational codes were reclassed according to categories used in the hedonic model. These categories included professional, manager, sales, clerical, craftsman, operative, transport equipment operator, nonfarm labor, and service. These variables took on a value of 1 if correct or zero if not. If an occupation designation was not available, then an "average" occupation was composed by assigning a value of 0.1 to all job categories. If the occupational variable was not classifiable, the minimum wage was assigned. The minimum wage was also assigned to students, retirees, and to unemployed persons. If the age of the respondent was missing or not reported, the mean age for males or females was assigned as necessary. If the respondent was under 15 years of age, minimum wage was assigned. Table A1.1 presents the predicted wage equations for males and females.

After the above transformations were completed, a predicted wage was calculated and adjusted for inflation by the CPI to bring it into compatibility with the years of the Sea Grant Survey. A mean wage of $9.70 was calculated based on 1010 wage predictions. The mean for males was $10.08 per hour, and the mean for females was $5.71 per hour (Table A1.2).

Table A1.3 displays the predicted wage against the age of sample respondents. Wages rise through age 30, then hold steady. Above age 50, hourly wage begin to fall off. Coefficient of variation measures show a wider dispersion of wages at younger and older ages. Table A1.4, predicted wage vs. experience (age - years of school - 6), demonstrates a pattern similar to that of the previous table.

Table A1.5 shows predicted wage against education. High school graduates had an average predicted wage of $9.64 per hour, while those with college attendance had a predicted wage of slightly over $11.00 per hour. Those with post-graduate education earned a predicted $15.16 per hour. Table A1.6 highlights wage differentials by race. Occupational wage differentials appear in Table A1.7. Professionals, managers, sales personnel, and craftsmen earned more than individuals not in those occupations. On the other hand, clerical

TABLE A1.1

Predicted Nominal Wage Equations (Log Form)

	Males		Females	
Variable	Coeff.	Mean Sub.	Coeff.	Mean Sub.
Intercept	.6313		.1792	
Educ	.0303		.0283	
$(\text{Education})^2$	.0011		.0009	
Experience	.0310		.0180	
$(\text{Experience})^2$	-.0005		-.0003	
Race (white = 1)	.1128		-.0243	
Veteran	.0348	0.404	----	----
Unemp (1978)	-.0124	6.109	.0024	6.081
Professional	.0862		.5631	
Manager	.1418		.5211	
Sales	-.0003		.1988	
Clerical	-.0992		.3901	
Craftsman	.0153		.4448	
Operative	-.1484		.2346	
Transportation	-.1178		.3663	
Nonfarm	-.1307		.1991	
Service	-.2506		.1664	
Injury Rate	.0110	8.877	.0117	6.423
Cancer	.2989	0.0196	.1051	0.013
Tot. Susp. Part.	.0007	66.97	.00034	67.20
Household Head	.2287	0.808	.0692	0.271
Union	.1777	0.317	.1910	0.173
VarOJT77	-.0022	4.583	-.0013	4.604
Crime	5×10^{-6}	6955.0	8×10^{-6}	7010.0
Sunshine	-.0017	60.236	.0001	60.22
Dual Job	-.0417	0.033	-.0252	0.0265
Knowlcan	3.771	0.0068	.606	0.0119
Lind	.5593	0.0116	.606	0.0119

TABLE A1.2

Predicted Hourly Wage, by Sex

Sex	Wage	N	C.V
Male	10.08	934	35.205
Female	5.71	75	39.202

TABLE A1.3

Predicted Hourly Wage, by Age

Age	Wage	N	C.V.
Under 15	3.35	14	0.00
16 - 20	5.77	24	36.04
21 - 25	7.88	80	28.08
26 - 30	9.18	115	24.24
31 - 35	11.13	146	19.14
36 - 40	11.53	140	20.85
41 - 45	11.55	116	27.92
46 - 50	11.36	95	31.57
51 - 55	10.79	85	35.21
56 - 60	8.50	87	49.43
62 - 65	6.27	54	62.75
Over 66	5.96	54	63.10

TABLE A1.4

Predicted Hourly Wage, by Experience

Experience (Years)	Wage	N	C.V.
0 - 5	6.78	90	43.70
6 - 10	9.56	117	27.22
11 - 15	10.48	126	23.04
16 - 20	11.74	125	22.42
21 - 25	11.54	126	25.31
26 - 30	11.53	93	27.75
31 - 35	11.28	92	30.93
36 - 40	9.50	75	41.40
41 - 45	8.21	66	41.77
46 - 50	5.76	45	50.32
Over 50	4.60	55	53.78

TABLE A1.5

Predicted Hourly Wage, by Education

Education	Wage	N	C.V.
2	4.16	16	30.36
5	5.08	41	43.35
8	7.20	102	36.52
12	9.64	540	30.46
14	11.01	140	27.46
16	11.09	121	38.28
18	15.16	48	22.98

TABLE A1.6

Predicted Hourly Wage, by Race

Race	Wage	N	C.V.
Non-white	7.83	133	43.61
White	10.04	877	35.90

TABLE A1.7

Predicted Hourly Wage, by Occupation

Occupation	Wage	N	C.V.
Nonprofessional	9.21	801	40.04
Professional	12.70	134	20.81
Nonmanagerial	9.08	787	39.83
Managerial	13.05	148	19.51
Nonsales	9.64	898	39.33
Sales	11.38	37	20.79
Nonclerical	9.71	911	39.13
Clerical	9.51	24	16.18
Noncraftsmen	9.45	683	44.80
Craftsmen	10.40	252	17.24
Nonoperative	9.73	899	39.23
Operative	9.04	36	17.48
Nontransportation	9.74	904	39.08
Transportation	8.78	31	19.84
Nonfarm Laborers	9.73	915	38.97
Other Nonfarm Laborers	8.68	20	16.10
Nonservice	9.79	900	38.74
Service	7.65	35	24.80
*Nonclassifiable	10.25	75	18.33

workers, operatives, transportation employees, nonfarm laborers, and service workers earned less than those in other occupations.

The original survey used two methods to elicit information about respondent income. First, respondents were asked to indicate an appropriate income category from a list of income ranges. Second, if respondents were willing to disclose actual income, it was recorded.

To compare the predicted wage with participant responses, actual income was divided by 2080 (52 weeks x 40 hours/week) to estimate hourly wage. Cross-tabulation for 1981 appears in Table A1.8, while 1982 data appears in Table A1.9. The numbers reflect frequencies of observations meeting both classification variables.

With the exception of the predicted wage category which includes the minimum wage ($3.35 per hour), estimated hourly wages compare well with predicted wage. The general trend throughout the table shows predicted wage rising with estimated income per hour. The concentration of observations in the minimum wage category is due to the assignment of minimum wage when key descriptive variables of the respondent are missing.

Despite potential dispersion problems discussed above, the predicted wage appears to be a reasonable measure for opportunity cost of time.

TABLE A1.8

Predicted Hourly Wage vs. Estimated Hourly Wage, 1981

	Predicted Wage											
Hourly Wage	2. - 2.99	3. - 3.99	4. - 4.99	5. - 5.99	6. - 6.99	7. - 7.99	8. - 8.99	9. - 9.99	10.- 10.99	11.- 11.99	>12.00	Row Total
0. - 0.99	1	5	1	2		2	1		1	2	1	16
1. - 1.99		4		1								5
2. - 2.99		6			2	4		1		1		14
3. - 3.99		6		1	1		4			1		13
4. - 4.99		10		1		3	6	7	6	2	1	36
5. - 5.99						1	1	2	2		2	8
6. - 6.99		10		1	3	1	6	4	6	1	1	33
7. - 7.99		3				7	6	1	5	3	2	27
8. - 8.99		4			2	6	5	9	7	6	11	50
9. - 9.99		1					4	3	3			11
10. - 10.99		5				7	11	10	10	7	10	60
11. - 11.99		1				1	1	2		2	4	1
12. - 12.99		2				1	2	2	1	4	5	17
13. - 13.99		4	1	1	1	2	6	6	7	13	7	48
14. - 14.99		1				1		3	2	4	1	12
15. - 15.99		6					3	1	4	7	16	37
16. - 16.99					1	2		1	2	4	1	11
17. - 17.99							1			1		2
18. - 18.99		1					1				2	4
19. - 19.99		1				1	2	5	4	11	11	3
20. - 20.99												0
21. - 21.99				1						2		3
22. - 22.99				1					2	2	8	13
23. - 23.99												0
> 24.		1			3	1	1	2	3	3	9	23
Column Total	1	72	3	7	16	43	62	58	60	75	92	489

TABLE A1.9

Predicted Hourly Wage vs. Estimated Hourly Wage, 1982

	Predicted Wage											
Hourly Wage	2. - 2.99	3. - 3.99	4. - 4.99	5. - 5.99	6. - 6.99	7. - 7.99	8. - 8.99	9. - 9.99	10.- 10.99	11.- 11.99	>12.00	Row Total
0. - 0.99		3						2				5
1. - 1.99												0
2. - 2.99		4	1		2		1	2				10
3. - 3.99												0
4. - 4.99		5		1	1	3	2	1		1	1	15
5. - 5.99		2				1				1	1	5
6. - 6.99		6	1			2	2	4		1	5	21
7. - 7.99		1						2	1			4
8. - 8.99		6		1			2	4	4	4	4	25
9. - 9.99		1					1	1		1	2	6
10. - 10.99		7				1	5	3	7	8	13	44
11. - 11.99				1				1	1			3
12. - 12.99		5		1	1	1	3	2	3	2	18	36
13. - 13.99								1		1	4	6
14. - 14.99		3				1	3	3	3	7	14	34
15. - 15.99									1	2	1	4
16. - 16.99		2		1			1	2	4	4	7	19
17. - 17.99									1			1
18. - 18.99									6	1	9	16
19. - 19.99								1				1
20. - 20.99								1	2		5	8
21. - 21.99								1			1	2
22. - 22.99					1	1	1				4	7
23. - 23.99												0
> 24.		1				3		3	3	6	34	50
Column Total	0	46	2	5	5	13	21	34	35	38	123	323

Appendix 2

Distance Traveled

In order to conduct travel cost analysis, two measures of distance traveled were used. As part of the original survey, respondents were asked about their county of residence and the distance from their home to the fishing site. The distances indicated by respondents exhibited great variability even among those from the same origin county. Because this variability suggested the possibility of measurement error in these reported distances, the distances traveled from each origin county to each of the fishing sites were calculated using available national, state, and county maps. This appendix describes the methodology used.

A list of all origin counties was compiled. The sample of 1012 respondents came from 156 origin counties. An origin city was selected as the origin point for all residents of each county. Choosing a city was generally straightforward. For example, it is usually possible to identify one city as the major population center of the county. If a county had no clear population center but was immediately adjacent to a major population center just across a county boundary, that major city was used as the measurement point. If a county was rural (close to no major or minor cities), a centrally located point, usually a county seat, was selected as the point of origin.

Routes of travel to the Albemarle-Pamlico area were assigned to each origin city. Travel was assumed to occur along major highways in a direct manner. Distance was calculated from each origin city to all fishing sites. To reduce the prospects for error and facilitate the process, trips were described as movements between nodes, so that distance between nodes would be measured once and total distance defined as the sum of the distances for the movements defined to comprise a trip. More specifically, each route was measured to each of three nodes: Williamston, Greenville and New Bern. Distance to sites along the Albemarle Sound were measured through Williamston; distance to sites along the Pamlico River were measured through Greenville; distance to sites along the Neuse River were measured through New Bern. The Williamston route was also used to calculate distance to Outer Banks sites.

Distance to fishing sites originating in coastal counties (i.e., North Carolina and Virginia) were measured individually using the most direct route.

Appendix 3

Catch Rate Calculations

To measure an aspect of the quality of the fishing experiences, the reported catch from the N. C. Sea Grant Survey was used to calculate the estimated catch rates for each of the entry points to the sounds. Site catch rates were constructed and assigned to their respective sites.

Two catch rates were calculated for the boat and bank fishermen. The first catch rate estimated number of fish caught per person per hour spent fishing, while the second catch rate estimated number of fish per person. This distinction is important for several reasons. We would expect the rates to be different for these two different approaches to fishing because of differences in the areas of the sounds that can be used by the two types of fishing practices. Moreover, specific features of the survey methodology further complicated matters. Boat fishermen were interviewed at the dock after their fishing day was complete. Bank fishermen, on the other hand, were interviewed while they were fishing. Consequently the second catch rate variable, catch per person, does not adequately control for either the total fish that may have been caught by the end of the trip or the length of time spent fishing for bank fishermen. Care must be used in interpreting this catch rate and in comparing it with the counterpart variable for boat fishermen.

The survey data included information on time spent fishing, striped bass kept and released, other fish kept and released, bait kept and released, and party size. All catch data referred to total fish caught by the entire fishing party. The first catch variable used the following formula:

$$\frac{\text{(all fish kept or released)}}{\text{(hours of fishing time) (party size)}} = \text{catch per person per hour}$$

The second catch rate variable used a slightly different formula:

$$\frac{\text{(all fish kept or released)}}{\text{(party size)}} = \text{catch per person}$$

If catch rates could not be calculated for any reason (e.g., if party size or time spent fishing were zero for all observations at a particular site), catch rates from adjacent sites were used to substitute for the missing catch rate.

Appendix 4

Motor Vehicle Operating Costs

An estimate of the cost of motor vehicle operation was used in the travel cost model. Many sources for this information are available, but estimates exhibit wide variation due to differing assumptions about depreciation rates and other factors. Two different cost estimates were considered. The first of these is based on information reported in Insurance Facts 1982-83 (New York: Insurance Information Institute). This publication reports the costs per mile given in Table A4.1 for operating a car per mile.

We omitted the large automobile and van categories, did not include the parking and tolls estimate, constructed a simple average of the other categories of costs for the remaining (mid-range vehicles), and adjusted it to 1981 dollars using the transportation component of the CPI. The result was 19.88 cents per mile, which we rounded up to 20 cents per mile.

The second estimate is from a different source and excludes depreciation. Here we considered the effects of including vans. The cost per mile ranged from 11.87 to 12.74 cents in 1981 dollars. The specifics are given in Table A4.2. In this case, we considered 12 cents a middle estimate.

The results reported in the text use the higher estimate. Because the prices include vehicle-related travel costs and the time costs of travel and fees, the difference between these two estimates is not simply a multiple of the implicit price. Results for the 12-cent estimate are available on request from the authors.

TABLE A4.1

High Cost Estimates for Operating an Automobile (Cents per Mile)

1981

	Categories of Expense					
Type	Depreciation	Maintenance and Accessories Parts & Tires	Gas & Oil	Parking & Tolls	Insurance	State & Federal Taxes
Large	7.7	6.0	7.3	0.8	3.3	1.5
Intermediate	6.2	5.6	6.6	0.8	3.3	1.3
Compact	5.9	5.0	5.3	0.8	3.3	1.1
Subcompact	4.7	4.8	4.5	0.8	3.1	1.0
Van	10.7	7.2	8.9	0.8	4.4	1.9

TABLE A4.2

Low Cost Estimates for Operating
an Automobile (cents per mile)

1981

Category	Type of Vehicle				
	Large	Intermediate	Compact	Subcompact	Van
Total Repairs & <u>Maintenance</u>	5.20	5.03	4.37	4.20	5.52
Tire	.72	.48	.48	.43	.73
Gasoline	7.17	6.42	5.08	4.35	8.71
Oil	.17	.17	.17	.16	.20
<u>Taxes</u>					
Gasoline (State)	.53	.47	.38	.32	.64
Gasoline (Federal)	.24	.21	.17	.14	.19
Tires (Federal)	.03	.03	.02	.02	.05
Sales Tax (State)	.09	.08	.07	.06	.09

Average excluding vans 11.87
Average including vans 12.74

Source: Statistical Abstract of U. S., 1982

Appendix 5

Lodging Costs

Estimates of lodging costs were also developed for the data set. These costs reflect the additional expense of a hotel/motel stay during a multi-day visit. In choosing a particular site to visit, visitors will include relative lodging expense in their decision.

The state of North Carolina's Department of Commerce periodically publishes a director of accommodations for the state. Hotels and motels are listed by community, and a range of prices for each hotel is given. For each fishing site, a town (or towns) was assigned as the available accommodation. Using the "North Carolina Directory of Accommodations," a simple average of the relevant listed costs was calculated and assigned to the sites close to the sites.

Appendix 6

Residual Discharge Estimates

This appendix describes the sources for our estimates of residual discharges into the sounds. Discharge measures for biochemical oxygen demand and suspended solids were estimated using 1984 NOAA data for waste-water treatment facilities in coastal North Carolina. Treatment facilities were identified and all recreation sites within ten miles downstream were assigned pollution values based on effluent discharges from the identified treatment plants. (The ten-mile zone as chosen arbitrarily.) If more than one plant was identified, the sum of the discharges was used.

Effluent data reflected concentrations of pollution in milligrams per liter. Discharge data was measured in million gallons per day. To calculate total discharges, the flow rate per day was applied to the concentration rates for each type of effluent.

Waste-water, nitrogen and phosphorus loadings were handled in a different manner. County level data were obtained from NOAA (for 1984), and loadings were divided into point, nonpoint and upstream sources. Point sources consisted of municipal water treatment plants, direct industrial dischargers and power plants. Non-point sources included crop land run-off and forest land run-off. NOAA also has a category called "upstream" waste-water. Discharges were measured in gallons per year and represent the aggregate of all sources within a county.

Recreation fishing sites within a particular county were assigned three values for waste-water loadings - point source, nonpoint source, and upstream.

In a similar manner, pollution values for nitrogen and phosphorus from each of three sources were also assigned. The unit of measurement was tons per year. Understanding the reasons for variations in a model's estimates so they can be reflected in how those results are used is an essential element in research designed to support policy analysis. Our planned activities with N.C. Sea Grant support were not intended to complete this process. Rather, they focus on developing the remaining modeling alternatives. Comparative evaluation and reconciliation of findings remain a separate set of tasks that are clear candidates for future research.

Appendix 7

Empirical Results with Alternative Travel Cost Definitions and Demand Specifications

This appendix provides examples of the other specifications tested. Table A7.1 provides brief variable definitions. Table A7.2 reports the OLS results for the two Outer Banks samples and Pamlico when a linear functional form was used with the preferred variables. Most previous studies have had better success with the semi-log specification that we used in the text, and these linear results confirm that choice. The coefficients are generally less significant and sometimes have the wrong signs.

Tables A7.3 through A7.5 report the results for the two Outer Banks samples and the Pamlico when the price or travel cost variable was calculated in different ways. The value of travel time could be estimated from the reported income in the manner described in the text. This is done in the first two columns in each table, while the last two columns use the implicit wage estimated using the respondent characteristics. The second and fourth columns allocate the costs of the trip according to the type of party (family versus nonfamily). As can be seen in all three tables, the travel costs developed using the hedonic wage technique had more explanatory power than when reported income was used in estimating travel costs. Generally, the full costs measures rather than the allocated cost measures proved superior, although as discussed in the text, the results for the full sample in the Outer Banks were also quite good with the allocated costs.

TABLE A7.1

Variable Definitions

Variable Name	Variable Definition[a]
TRIPS	Trips
LNTRIPS	Natural log of TRIPS
PRICE	Travel Cost (various definitions)
PRICETCS	Travel Cost (time cost based on income, costs not allocated by party type)
PRICEFAC	Travel Cost (time cost based on income, costs allocated by party type)
PRICETWS	Travel Cost (time cost based on hedonic wage, costs not allocated by party type)
PRICEFAW	Travel Cost (time cost based on hedonic wage, costs allocated by party type)
INCC	Income
FISHYR	Years Fishing
AGE	Age
CRB1	Catch Rate
PRICECT1	Catch Rate * Appropriate Travel Cost
PAMPRIC1	Pamlico Travel Cost
ALBPRIC1	Albemarle Travel Cost
OBPRIC1	Outer Banks Travel Cost

[a] More detailed definitions of these variables are contained in Table 5.2.

TABLE A7.2

Linear Specification
Dependent Variable: TRIPS

	Outer Banks All Obs.	Outer Banks w/in 200 miles	Pamlico All Obs.
INTERCEPT	33.0442 (3.479)	31.6912 (2.749)	2.6244 (0.095)
PRICETWS	-.0736 (-1.338)	-.1607 (-1.474)	-.4932 (-3.107)
INCC	1.28E-04 (1.043)	1.48E-04 (1.035)	1.34E-05 (0.065)
PRICECT1	.0215 (1.996)	.0278 (0.808)	.0306 (1.134)
FISHYR	.7332 (3.856)	.5739 (2.442)	.7729 (2.351)
PAMPRIC1	.1341 (2.026)	.2621 (3.390)	
OBPRIC1			-.061 (-0.205)
ALBPRIC1	-.1344 (-1.476)	-.2356 (-1.889)	.4695 (1.763)
AGE	-.5376 (-2.455)	-.4288 (-1.559)	-.0535 (-0.142)
N	260	154	111
R^2	.1094	.1785	.2042
F	4.421	4.531	3.777

TABLE A7.3

Alternative Prices
Outer Banks, All Observations
Dependent Variable: LNTRIPS

	PRICETCS	PRICEFAC	PRICETWS	PRICEFAW
INTERCEPT	2.788 (9.872)	2.844 (9.082)	2.9 (10.352)	2.793 (8.940)
PRICE	-.0013 (-1.276)	-.0045 (-1.977)	-.0038 (-2.393)	-.0068 (-1.984)
INCC	1.07E-05 (2.250)	4.2E-6 (0.831)	9.50E-06 (2.651)	7.18E-6 (1.698)
PRICECT1	.0003 (1.669)	-.0021 (-2.391)	.0005 (1.683)	.0028 (2.155)
FISHYR	.0320 (5.511)	.0273 4.076	.0311 (5.394)	.0272 (4.021)
PAMPRIC1	.0060 (3.112)	.0086 (3.827)	.0055 (2.811)	.0080 (3.583)
ALBPRIC1	(-.0060) (-2.649)	-.0089 (-3.756)	-.0036 (-1.358)	-.0079 (-3.196)
AGE	-.0228 (-3.434)	-.0207 (-2.839)	-.0223 (-3.384)	-.0205 (-2.797)
N	255	188	255	188
R^2	.2035	.1933	.2141	.1864
F	9.015	6.163	9.613	5.891

TABLE A7.4

Alternative Prices
Outer Banks, within 200 miles
Dependent Variable: LNTRIPS

	PRICETCS	PRICEFAC	PRICETWS	PRICEFAW
INTERCEPT	2.508 (6.769)	2.745 (6.377)	2.6778 (7.246)	2.785 (6.521)
PRICE	-.0054 (-1.939)	-.0069 (-1.080)	-.0085 (-2.505)	-.0090 (-0.979)
INCC	1.5E-5 (2.098)	5.1E-6 (0.618)	8.90E-06 (1.977)	4.9E-6 (0.944)
PRICECT1	9.5E-4 (1.081)	.0024 (0.945)	.0012 (1.147)	.0024 (0.692)
FISHYR	.0248 (3.221)	.0220 (2.430)	.024 (3.140)	.0219 (2.398)
PAMPRIC1	.0096 (3.613)	.0117 (3.670)	.0098 (3.975)	.0113 (3.920)
ALBPRIC1	-.0071 (-1.844)	-.0118 (-2.660)	-.0048 (-1.217)	-.0098 (-2.182)
AGE	-.0149 (-1.672)	-.0152 (-1.515)	-.0147 (-1.667)	-.0154 (-1.534)
N	152	117	152	117
R^2	.2529	.2416	.2694	.2423
F	6.965	4.962	7.585	4.979

TABLE A7.5

Alternative Prices
Pamlico, All Observations
Dependent Variable: LNTRIPS

	PRICETCS	PRICEFAC	PRICETWS	PRICEFAW
INTERCEPT	3.819	3.901	3.1961	3.784
	(5.483)	(4.753)	(4.325)	(4.311)
PRICE	-.0046	-.0053	-.0124	-.0113
	(-1.774)	(-1.615)	(-2.917)	(-1.671)
INCC	7.3E-6	1.4E-5	-2.80E-6	4.1E-6
	(1.101)	(1.909)	(-0.506)	(0.589)
PRICECT1	3.5E-4	.0002	.001	.0006
	(0.705)	(0.297)	(1.332)	(0.481)
FISHYR	.0156	.0132	.0135	.0116
	(1.691)	(1.226)	(1.516)	(1.081)
OBPRIC1	-.0187	-.0229	-.0125	-.0148
	(-2.457)	(-2.753)	(-1.559)	(-1.519)
ALBPRIC1	.0212	.0286	.0222	.0217
	(2.855)	(3.073)	(3.085)	(2.290)
AGE	-.0090	-.0151	-.0045	-.0142
	(-.888)	(-1.331)	(-0.440)	(-1.211)
N	109	79	109	79
R^2	.1680	.2220	.2096	.2135
F	2.914	2.894	3.826	2.753

Appendix

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