THE ECONOMIC VALUE OF MID AND SOUTH ATLANTIC SPORTFISHING
Vol. 2

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Preface

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THE ECONOMIC VALUE OF RECREATIONAL FISHING

1.1 INTRODUCTION

This report is a study of the economic value of marine recreational fishing on the East Coast of the U.S., from Long Island, New York to Key Biscayne, Florida. It is the second in a series on the economics of recreational fishing in this region.[1] This study is concerned with the value of recreational fishing opportunities to anglers, not individuals and firms providing services to those anglers. It contains an analysis of responses to questions concerning individuals' preferences, both stated and revealed, for sportfishing sites.

The ultimate goal of the project is to document the value of marine resources derived from recreational fishing from New York to Florida. Sportfishing has economic value in that anglers would be willing to pay more for their opportunities than their actual expenses on fishing. The value of opportunities for recreational fishing depends on many aspects of the opportunities—the quality of fishing, the weather, the skill of the angler, and so forth. There are two kinds of economic values of interest: 1) the access value, that is, what anglers would pay rather than do without access to the resource; and 2) the value of a change in the quality of fishing, or what anglers would pay for increments in fishing characteristics such as the catch rate.

Documentation of the value of marine recreational fishing will likely play a role in policies involving marine resources. There are currently several major pieces of legislation which influence recreational fishing. The Clean Water Act, under consideration for re-authorization in the current session of Congress, is perhaps the most important. Parts of this Act relate to wetlands and estuaries. Wetlands are a breeding ground for important marine species such as striped bass, snook and others. An understanding of the economic value of fishing for these species plays a critical role in allocating funds to protect wetlands. The Endangered Species Act is also being debated. An important implication of this Act is that listing a recreationally harvested species as endangered may mean short-run losses and long-run gains. The Magnuson Fisheries and Conservation Act is in final hearing. Knowledge of the magnitude of economic value may provide the incentive to invest in managing and preserving fish stocks. There are many other reasons for estimating the economic value of recreational fishing, including use of these values as input for natural resource damage cases.

This study is useful in understanding the final link in a complex sequence from human actions to environmental and natural resource effects to human reactions. In the simplest version of this sequence, policy is designed to reduce pollutants which harm natural resources. The reduction in pollution improves water quality and hence enhances fish stocks, which in turn improves recreational fishing. Anglers benefit from the policy through the enhanced economic value they derive from improved recreational fishing.

While this research project deals broadly with the impact of marine pollution on human well-being, the report concerns only the last link in this complex process: the effect of changes in catch rates on the economic value of recreational fishing to the people who do the fishing. Given the nature of the available data, we can investigate issues that arise only at the state level or, perhaps, at the county level within a state. Our study area is the Atlantic coast from Long Island south through Florida, excluding the Keys. We thus have considered a large domain, but a small part of the potentially large geographical range of marine pollution. However, it is an area which accounts for a substantial portion of the nation's marine recreational fishing and it is part of a larger strategy to document the economic value of marine natural resources.

In the process of linking enhanced stocks with greater economic value, we have frequently been asked to compute baseline economic values for states in the region based on 1988-1989 activity. It has been a lengthy process to develop these estimates and it is with a certain confidence that we present them in this report.

Methods for estimating economic value blend statistical methods and economic models with data on how people have carried out their recreational fishing activities. Information on recreational fishing is not easily obtained. Marine recreational activity is a highly diverse activity. It occurs over wide geographic areas and in many different forms. In particular, anglers seek a sportfishing experience, a good not sold in a market but naturally provided by marine resources. Households actually "produce" recreational trips by allocating their time, buying market services, and combining these with publicly provided natural resources. The absence of a market necessitates special surveys to gather information on the behavior of recreational anglers. Consequently, as a part of this study, we have engaged directly or indirectly in preparing survey data which can be used to infer the economic value of marine recreational fishing and how this value changes with factors which depend on the quality of marine water, such as catch rates.

The necessity of gathering data for studying the economic value of marine recreational fishing explains the role of this report. In a study for an area as large as New York to Florida, a great many observations on behavior are needed. We have engaged in extensive construction of data sets from surveys conducted by and for the National Marine Fisheries Service over the last 15 years. We employ these data sets to help estimate economic value.

To appreciate the economic analysis that follows, it is necessary to have an understanding of the surveys that were undertaken. A sample model of economic value can help. Suppose our goal is to calculate a state's total willingness to pay for an improvement in the catch rate for a given species. Let M(q) represent a representative angler's willingness to pay to catch more fish (q) of a given type. Let P be the state's population and Π be the probability that a randomly drawn person from the state engages in marine angling. Then the state's total willingness to pay for (or sell[2]) an increased catch rate is,

(1.1) $$\text{Total willingness to pay} = P \times \Pi \times M(q)$$

= Population × Participation rate × Representative angler's willingness to pay.

While the actual analysis is considerably more complicated, it follows this principle. Three surveys are used in these estimations and calculations. The representative willingness to pay, M, is estimated using information from the economic survey conducted for the University of Maryland (UMCP). The National Marine Fisheries Service (NMFS) intercept survey provides information on catch rates which allows M to be linked to q. The NMFS phone survey is a survey of the population which allows Π to be estimated. These surveys are described below.

1.2 THE MARINE RECREATIONAL FISHING SURVEYS

In this report, marine recreational fishing on the Atlantic coast is analyzed with data from three surveys. Two of the surveys are part of the Marine Recreational Fishery Statistical Survey sponsored by the National Marine Fisheries Service (NMFS). They are the Intercept Survey and the Household Telephone Survey (Phone Survey for short). The third survey was conducted as part of this project at the University of Maryland, to provide information for the economic aspects of the study (called the UMCP survey for short). The UMCP survey was designed to generate information necessary for estimating economic models. However, the NMFS surveys were originally designed with the biological task of estimating total recreational catch in mind. Some understanding of these surveys can give an appreciation of the strengths and weaknesses of our statistical descriptions as well as the role these surveys play in estimating recreational catch.

1.2A The NMFS Surveys

Knowing how NMFS uses its surveys to estimate total catch is essential to understanding the surveys themselves. The historical goal of the surveys has been to estimate total catch by species for major species. In principle, the procedures are clear. An estimate of the total catch of a species by geographical area and time period (say a year) can be made from the mean of the number of fish caught per trip times the number of trips. The principal goal of the Intercept Survey is to estimate the number of fish caught per trip. The Phone Survey is used to estimate the number of fishing trips in the area of interest. The product of the mean catch rate and the number of trips is the estimate of total catch. These surveys are carried out independently of each other by contractors for NMFS.

The Phone Survey

NMFS initiated the Phone Survey in 1979. The survey is conducted by a commercial contractor. It is a random-digit-dialing survey of households living near the coast. Households are interviewed at the end of a two-month wave and asked about their recreational fisheries activities during the previous two-month period. For most of the states in our study area, sampling is undertaken in only five two-month waves: March-April, May-June, July-August, September-October, and November-December. No surveys are conducted during the January-February wave except in Florida and Georgia. The NMFS publication entitled Marine Recreational Fishing Statistics Survey explains their survey in depth.

For the most part, calls are made only to households located in counties within 25 miles of the coast, major bays, or estuaries. The random-digit-dialing procedure accepts only households. The interviewer first asks whether anyone in the household has fished during the last two months. The interviewer then attempts to talk to all household members who had fished during the previous two months.

The survey includes questions about whether any member of the household fished within the last two months. Each member is asked the following questions about each trip taken within the last two months:

— mode of fishing

— type of gear

— type of waterbody

— distance from shore.

The questions have remained approximately the same over the life of the survey, although some revisions took place between the 1980 and 1981 survey. Starting in 1981, respondents were specifically asked for information only if they fished in-state, and since that time, trip information has been coded only for in-state trips. Additionally, information has been coded since 1981 only for those households in which at least one member fished in the interview wave.

The Phone Survey is critical to the entire survey scheme because it is the only instrument applied randomly to households residing in defined geographical areas. Without it, there would be no way to obtain participation rates or estimates of total numbers of sportfishing participants or trips. Since the telephone survey samples only coastal residents and includes only in-state trips, information from the field survey must be combined with the telephone survey results to extrapolate participation and trips of non-coastal and out-of-state residents.

The telephone survey is designed to elicit responses about fishing in the previous two months, because accurate recall beyond two months is considered questionable. However, the two-month wave design introduces some unusual problems for traditional economic analysis, which is typically based on yearly behavior. For example, it is not feasible to obtain good estimates of the annual participation rates by households or by individuals from the Phone Survey.

Variations in the range of households interviewed cause additional problems for the two-month participation rates. For the Mid-Atlantic region (New York, New Jersey, Delaware, Maryland, and Virginia) only counties within 25 miles of the Atlantic Ocean are called in all waves. For the South Atlantic (South Carolina, North Carolina, Georgia, and Florida), excluding North Carolina, households are sampled from counties within 25 miles of the coast during the March-April and November-December waves,[3] but from counties within 50 miles of the coast from May through October. The sampling scheme in North Carolina was identical to that of the rest of the South Atlantic until 1987. Since 1987, households in North Carolina have been sampled from counties within 50 miles of the coast in March-April and November-December and from counties within 100 miles in May through October. These complications are summarized in Table 1.1 below for reference.

Table 1.1 Telephone Sample Frame

Sample Range[a]	States	Years	Waves[b]
25 miles	New York	1980-1989	2 through 6
	New Jersey	1980-1989	2 through 6
	Delaware	1980-1989	2 through 6
	Maryland	1980-1989	2 through 6
	Virginia	1980-1989	2 through 6
	North Carolina	1980-1986	2 and 6 only
	South Carolina	1980-1989	2 and 6 only
	Georgia	1980-1989	2 and 6 only
	Florida	1980-1989	2 and 6 only
50 miles	North Carolina	1980-1986	3, 4, and 5
	North Carolina	1987-1989	2 and 6
	South Carolina	1980-1989	3, 4, and 5
	Georgia	1980-1989	3, 4, and 5
	Florida	1980-1989	3, 4, and 5
100 miles	North Carolina	1987-1989	3, 4, and 5

[a]The sample range refers to the distance between the coast or an estuary of the coast to the most distant county in the sample.

[b]The waves are occasionally referred to by number, where 1 is January-February; 2 is March-April; 3, May-June; 4, July-August; 5, September-October; and 6, November-December.

The Intercept Survey

The Intercept Survey was also initiated in 1979. It is conducted by commercial contractors, but usually with substantial involvement from state fisheries agencies. The Intercept Survey is organized along the same two month waves as the Phone Survey. The Intercept Survey is designed to be a random survey of fishing trips. Each state is sampled separately, because of the close working relationship with the state agencies. The survey is a type of cluster survey, where the basis of cluster is a site. The commercial contractor to NMFS typically keeps a list of fishing sites, the kinds of activities that occur there, the typical level of its use during different seasons, and other attributes. The sites to be sampled can then be chosen first, with a specified level of sampling effort assigned to each chosen site. The site list changes slightly over time and keeping track of those changes is a challenge. There are over 1,000 sites in our study area.

The Intercept Survey protocol determines how anglers at a particular site are to be chosen. Those fishing from shore are interviewed as they are intercepted. Boat anglers are interviewed after their fishing trip (although occasionally interviewers accompany anglers on party boats and interview during the trip). The intercepts are sampled by mode. The four aggregate NMFS modes are party/charter boat fishing, private/rental boat fishing, beach/bank fishing, and fishing from artificial structures. This covers most recreational fishing, omitting only those anglers who moor their fishing boats at home or at other moorings inaccessible to sampling. We have aggregated the beach/bank and artificial structures into a single mode, the shore fishing mode. The method of interview varies by mode. The aggregate sampling effort within a state varies by wave, with more effort naturally given to the waves when the angling effort is likely to be large.

The focus of the NMFS interview is on the current trip of the angler. In essence, it is a creel survey, with some additional social and economic data gathered. Each angler interviewed is asked

— place of residence

— length of trip

— target species

— number and species of fish caught.

In addition, the interviewer measures the weight and length of a sample of the fish caught by the angler. Anglers are also asked about the number of trips they have taken in the past twelve months and in the past two months.

The NMFS Intercept Survey is an excellent method for gathering information about fish caught by individual anglers. The few weaknesses are inevitable and well known by the survey designers. Boat anglers pose problems, for example, because they tend to group catch together and so it is difficult to determine the fish caught by an individual angler. Fish which are caught and thrown back cannot be weighed and measured, and the species may not be known. One difficulty for the estimation of economic models from intercept data is that the random sampling of trips does not result in a random sample of individuals. The probability of selecting an angler is proportional to his share of the total trips taken. That is, if angler i takes x_i trips, and there are N anglers the probability of randomly selecting angler i is $x_i \Big/ \sum_{j=1}^{N} x_j$.

There is not always consistent sampling across mode and wave. The most important inconsistency is in the South Atlantic. In this region, surveys are not conducted for party or head boat anglers. While we have made corrections for this deficiency, it does affect the inherent error in our estimate for the party/charter mode in the South Atlantic.

The Intercept Survey is a substantial undertaking. Over the period from 1980 to 1989, over 200,000 anglers have been interviewed in the Middle and South Atlantic. Because the purpose of the Intercept Survey is to assess catch per trip of individual species, much effort has gone into accurate measurement of the number and weight of fish caught by anglers. But this purpose is slightly different than ours, so variations in the analytic procedure have been made.

Our challenge is to utilize the data in a manner that will reflect those characteristics of a fishing trip which influence angler's behavior. The most obvious characteristic is the expectation of how many fish the angler can expect to catch on any given trip. Consequently, we group species in ways that reflect individuals' perceptions and targeting behavior.

In forming measures of catch rates which influence behavior, we aggregate over sites, species, and years because the data are too sparse to allow reliable estimates of more disaggregate catch rates. There are at least 25 species that anglers regularly seek in the study area. There are four modes, five waves, and ten years of sampling. Even if the distribution of fishing were uniform across the modes, waves, species, and sites, a uniformly distributed sample of 100,000 would encounter only one of every five mode-species-wave-year-site cells. Naturally, the sample is not evenly distributed over sites. As a consequence of the diversity of these characteristics, we have been compelled to aggregate.

In the state sections that follow, we have aggregated in three significant ways:

1. Over modes: The two NMFS shore modes, bank/beach fishing and fishing from artificial structures, have been aggregated into one shore fishing mode. We have three modes:

    a. party/charter boats
    b. private/rental boats
    c. shore

2. Over sites:

   a. For the contingent valuation studies, we have aggregated all the NMFS Intercept Survey sites within each state to the state level. All of the catch information is provided at the state level.

   b. For the behavior-based valuation, we have tried to aggregate over NMFS sites up to the county level. However, in some cases the counties were too large; in others too small. The list of aggregate sites for the behavior-based analysis is given in Appendix A.

3. Over species: The most important aggregation is over species. There are simply too many different species to present trends of catch rates and other information by species. Further, species have less significance for individual behavior than groups of species. Most anglers can only identify a small number of species. They cannot be expected to be motivated by the catch rate of species unfamiliar to them. We have aggregated the myriad of species into four groups:

   a. big gamefish
   b. small gamefish
   c. flatfish
   d. bottomfish
   e. other

The classification of the different species into the four groups is given in Table 1.2. Our results are reported in terms of the first four groups of species.

Our second major modification of the NMFS Intercept Survey data concerns the targeting of species. We are interested in the availability of these aggregate groups to anglers. Averaging the catch rates of only those anglers who target species in the particular aggregate group provides a more accurate measure of abundance than averaging catch rates of all anglers for the species group. After all, the catch of big gamefish species for an angler in a small boat fishing for flatfish will not reflect the ease with which big gamefish species can be caught. Averaging catch only for anglers who target each species group reduces the number of observations (sometimes by as much as 60%) but improves the information content of the resulting catch rate estimates.

1.2B The UMCP Survey

One survey was undertaken as part of this study. This survey gathered economic data not available from either of the NMFS surveys. The UMCP survey was designed to obtain information on the distribution of trips, the costs of those trips, and other household demographic information, for anglers who went saltwater fishing during a NMFS wave.

Table 1.2 Aggregation of Species into Groups

Small Game		
Striped Bass	Bluefish	Jack
Pompano	Seatrout	Bonefish
Bonito	Snook	Red Drum
Barracuda	Mackerel	
Bottom Fish		
Sandbar Shark	Dogfish Shark	Cat Shark
Sand Tiger Shark	Smooth Dog Shark	Carp
Catfish	Toadfish	Cod/Codfish
Pollack	Hake	Sea Robin
Sea Bass	Sawfish	Grunt
Kingfish	Mullett	Tautog
Butterfish	Nurse Shark	Brown Cat Shark
Porgy/Scup	Sheepshead	Pinfish
Snapper	Grouper	Perch
Black Drum		
Flat Fish		
Summer Flounder	Winter Flounder	Southern Flounder
Sole	Founders	
Big Game		
Blue Shark	Tuna	Marlin
Thresher Shark	Great Hammerhead	Swordfish
Shortfin Mako Shark	Tiger Shark	White Shark
Smooth Hammerhead	Scalloped Hammer	Tarpon
Billfish	Sailfish	Dolphin
Cobia	Wahoo	
Other Fish		
Herring	Eel	Skate
Puffer	Blacktip Shark	Requiem Shark
Dusky Shark	Atlantic Sharpnose	Bull Shark
Smalltail Shark		

The UMCP survey was conducted from November/December 1987 to November/December 1988. The sample frame consisted of all people who were interviewed on the NMFS Intercept Survey. A portion of the intercepted anglers were asked if they would answer phone questions on their fishing activities during the wave in which they were intercepted. They were then called at the end of that wave. Some portion of those called were also contacted for information in the subsequent two month wave. During the phone call, respondents were asked about all of the trips they took during the two month period. The questions for each trip included

— trip destination
— whether the trip was a day trip or overnight trip
— mode of fishing
— species group targeted
— specific variable costs of the fishing activities
— travel time and distance data
— type of waterbody

The interviewer also gathered data on the individual interviewed, including

— place of residence
— income and earnings data
— boat ownership
— second home ownership.

The interviewer also asked several hypothetical or contingent valuation questions. These questions form the basis for the value estimates of Chapters 3 and 4. The actual questionnaire is presented as Appendix B.

Table 1.3 gives the sampling effort for the UMCP Survey. Each cell in this table contains two numbers. The upper number is the number of people intercepted in that state of residence and wave, and who were subsequently called to complete the economic survey. The lower number in parentheses is the number of "second" interviews—that is, the number of people who were called in this wave but had been intercepted and interviewed in the previous wave. For example, in wave 2 in Delaware, 56 of the people intercepted in the field were called and interviewed about their activities during wave 2. All 56 of these respondents were called later for information concerning wave 3. Only 37 of the 56 were actually interviewed in the following wave, as can be seen from the figure in parentheses in the subsequent cell. Hence, in wave 3 in Delaware, there were 119 interviews, 82 who were intercepted by NMFS in wave 3 and 37 who were intercepted in wave 2 and called both in wave 2 and wave 3. In total, the UMCP survey completed almost 10,000 phone interviews.

Table 1.3 Sampling Effort in the UMCP Survey

State of Residence	Wave 1 Jan/Feb	2 Mar/Apr	3 May/Jun	4 Jul/Aug	5 Sep/Oct	6 Nov/Dec	State Totals
Delaware	-- (22)	56 --	82 (37)	105 (62)	94 (80)	30 (78)	367 (279)
Florida	154 (121)	247 (97)	282 (179)	347 (203)	234 (253)	164 (180)	1,428 (1,033)
Georgia	36 (37)	37 (24)	33 (28)	34 (22)	49 (25)	51 (40)	240 (176)
Maryland	-- (8)	41 --	119 (22)	170 (86)	50 (124)	9 (39)	389 (279)
New Jersey	-- (75)	27 --	244 (15)	330 (176)	174 (255)	92 (143)	867 (664)
New York	-- (93)	64 --	165 (39)	309 (105)	180 (212)	121 (139)	839 (588)
North Carolina	3 (96)	40 (0)	163 (30)	241 (120)	201 (176)	117 (154)	765 (576)
South Carolina	45 (41)	62 (19)	90 (38)	50 (68)	44 (34)	52 (31)	343 (231)
Virginia	-- (2)	27	220 (16)	180 (164)	100 (137)	2 (82)	529 (401)
WAVE TOTALS	238 (495)	601 (140)	1,398 (404)	1,766 (1.006)	1,126 (1,296)	638 (886)	5,767 (4,227)
Grand Total							9,853

1.3 ECONOMIC VALUES MEASURED

Our goal is to estimate two kinds of economic values. First, we are interested in the value of access to aggregate fishing sites or areas. This is the amount of money anglers would pay for fishing access to an area, or the amount they would accept in compensation for the loss of access to the area. The area access value indicates the economic importance of recreational fishing in that area. Obviously this varies spatially and temporally.

The second kind of value is the marginal value of catching fish; that is, the amount an angler is willing to pay to catch an additional fish. This of course depends on many things, such as the species sought, the time when the fishing takes place, the mode of fishing, and so forth.

The valuing of fish catch has a useful role in resource policy. Information about the recreational value of catching fish can help in fishery management decisions, such as allocating fish stocks between commercial and recreational users. It can also be useful in understanding the benefits of pollution clean-up policies. The linkages in such policies are conceptually clear but extraordinarily difficult to construct empirically. Clearer water lowers fish mortality, which raises stock density. With more fish, anglers find it easier to catch fish. Many policies, such as water quality improvements, affect individuals only when they increase the density of fish stocks.

In this report, we have assumed that the fishing success measures are exogenous to the angler, although it is likely that anglers with different skills can expect to catch different numbers of fish. Nonetheless, stock density certainly influences the catching of fish, and is, indeed, exogenous to the angler. In the following chapter, we develop an empirical model of the catching of fish that aids in measuring the value of access and the value of increased fish catch, estimated in Chapters 3, 4, and 5.

1.4 PREVIEW

We begin by presenting a model of how recreational anglers develop expectations about fish catch from their experiences catching fish (Chapter 2). This is critical because the rest of the report uses the analysis to compute expected catches for our sample. The expected catches along with travel costs and travel time to sites are the primary factors for predicting how individuals will 1) respond to our contingent valuation question (Chapters 3, 4) and 2) select fishing mode, species sought, and site (Chapter 5). Based on our model of contingent and actual behavior, we are able to derive values for access to sites, of different types of trips, and different types of species. Comparisons among them and conclusions are drawn in Chapter 6.

ENDNOTES

1. The first volume was Marine Recreational Fishing in the Middle and South Atlantic: A Descriptive Study, Report on Cooperative Agreement #CR-811043-01-0 between the University of Maryland and the Environmental Protection Agency, National Marine Fisheries Service, and National Oceanic and Atmospheric Administration, by Ivar E. Strand, K.E. McConnell, and Nancy E. Bockstael, Department of Agricultural and Resource Economics, and David G. Swartz, Maryland Sea Grant Program, University of Maryland, College Park, Maryland (August 1991).

2. Theoretically and practically, one expects a difference in these values. In our report, we present values based on both measures.

3. Also during the January-February wave for Georgia and Florida. However, for consistency across states we have omitted this first wave from consideration.

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Chapter 2
MODELLING CATCH RATES

2.1 INTRODUCTION

In the study of recreational fishing, it is important to give due consideration to catching fish as part of the entire sportfishing experience. In this chapter, we describe a model of how anglers catch fish and we report the estimation results for the major species groups. Recall the chain of events involved in evaluating benefits from environmental improvements—the environmental improvement enhances the abundance of fish, the enhancement increases the quality of recreation, and the better quality is valued by the angler.

The quality of a fishing trip may be measured in a variety of ways. For example, Vaughan and Russell (1982) argue for abundance. Typically abundance is measured as the number of fish or biomass of a species/species group available per unit time. In the present study, we measure quality by the number of fish of a species group caught (not necessarily kept) per trip by an angler seeking that species group. Sometimes we compute this catch rate by dividing the daily catch by hours fished. Usually, however, daily catch is used for each of the four species groups for various wave, mode, state combinations.[1]

As the sole measure of the quality of a site, the daily catch or catch rate has several shortcomings. It tells us nothing about the size of fish and nothing about the variability. A catch rate of two fish per day in the small game category could mean two one-pound bluefish per four hour trip or two ten-pound snook on an eight hour trip. Despite the difficulties in using a single measure, number of fish, to represent a host of different variables, it is the best measure that is available on a systematic basis. Despite its imperfections, use of daily catch has some merits. For beginning anglers, catching fish is very important. The number of fish per outing is important for most anglers.

Choosing daily catch as the measure of quality at a site is only one step in the modelling process. Catch variables can be computed in a variety of ways. Examples from selected marine economic studies are listed in Table 2.1. These catch rate definitions have been used with random utility models, not contingent valuation models, but quality variables play similar roles in both models. Freeman (1993) provides a broad survey of the economics of marine fishing, including treatment of catch.

Table 2.1 Measures of Angling Quality in Random Utility Models of Recreational Fishing

AUTHORS	MEASURE OF QUALITY
Arndorfer and Bockstael	Actual catch rates are reported although there is a discussion of preliminary regressions which used expectations.
Bockstael, Graefe, Strand and Caldwell (1986)	Expectations of catch at different artificial reef sites. Also expectations of the likelihood of being skunked.
Bockstael, McConnell and Strand (1989)	Catch rate from NMFS survey[a] for one of four species/mode group interacted with dummy variable which determined whether angler sought a species within the group.
Kaoru	Average number of fish actually caught by anglers interviewed at each site, from North Carolina recreational fisheries survey which generated trip data.
Milon	Mean pounds of fish (kept or released) per unit fishing effort for each site from mail survey of Dade County, Florida; coefficient of variation for pounds of fish per unit effort, from mail survey of Dade County Florida; survey also generated choice data.
Morey, Rowe and Shaw[b]	Mean catch per angler by species group, from NMFS data; mean catch per catch per angler catching the species, from NMFS data; mean catch per angler targeting the species, from NMFS data.
Thomson	Percent of anglers in NMFS survey targeting species who caught at least one of the species, by mode and area; percent of all anglers, by mode and area, who land at least one fish of any species, from NMFS survey.
Wegge, Carson and Hanemann	An index of the quality of fishing for each species group, by site and week; a site rating for species at the site.

[a]All data in this table which are described as NMFS survey data come from the NMFS intercept survey.

[b]As defined in Rowe et al., pp. 4-24.

The measures of catch and success variables in Table 2.1 can be classified into three types: historic objective, sample-specific objective, and sample-specific subjective. The historic objective variables are usually based on past sampling of anglers, such as with the NMFS intercept or creel surveys. The NMFS survey was designed to measure catch per trip for the "representative" angler for various species. Estimates of aggregate catch stem from expanding information taken during the intercept survey. The NMFS survey also allows the calculation of the percent of successful anglers. Bockstael et al. (1989), Morey et al. (1987), and Thomson (1988) use this type of quality variable. The sample-specific objective measures are derived from individual daily catches observed during the same trips under analysis. The Milon (1988), Kaoru (1988), and Arndorfer and Bockstael (1986) studies use this type. The subjective type is simply an index, created by persons knowledgeable about the sites and the activities that take place there. The Wegge et al. (1988) and Bockstael et al. (1986) papers use a subjective index. In modelling the effects of a quality variable, there is a tradeoff between measures of perception and objective measures. Of the studies in Table 2.1, only Bockstael et al. (1989) use an objective measure and, at the same time, allow some variation of the quality variable across individual anglers. They interact a mean historic catch with an individual-specific dummy variable associated with a species. But this only assured that the correct mean catch rate is applied to an angler seeking a particular species group. Catch rates are the same for anglers seeking a given species.

The approaches in Table 2.1 relate directly to our modelling choices. Our construction and development of NMFS data would allow us to use NMFS historic catch by site or by state. However, this would require all anglers at a site to experience the same catch rate. Because we selected our sample from anglers who had been interviewed by NMFS, and hence had their fish weighed, measured, and counted, we could use the interview data. This would provide for variation across individual anglers, but at the expense of a (probably considerable) random element in each catch. The subjective approach has the drawback that it cannot be expanded beyond the sample, and is ruled out here as no attempt was made to gather subjective assessments of fishing.

The approach we use in this report, which has been developed elsewhere (McConnell, Strand and Blake-Hedges, 1991), specifies the catch for a given angler of a given species group to be a random process, conditioned on certain known characteristics of the time, the location, the species group, and the angler. In effect, it is a stochastic household production function.

Let Q_{ik} be the catch rate for species k, angler i. The Q_{ik} is measured as a rate—the number per day. It varies across anglers because they have different information and expectations about sites, different skills and experience. For a given angler, Q_{ik} will depend on the density of fish at the site. It will also be random. We assume:

1. Given the amount of time spent fishing, the number of fish caught per trip is a random variable, conditional on angler and site characteristics;

2. This random process is Poisson.

Hence the distribution function of catch for angler i, species k is

(2.1) $$Q_{ik}^{n} = e^{-Q_{ik}}/n! \qquad n = 0, 1, \ldots\infty$$

where n is the number caught per trip. The mean number caught is

$$E(n) = Q_{ik}$$

where Q_{ik} is conditional on individual characteristics and site characteristics according to

(2.2) $$Q_{ik} = \exp\{\alpha_k x_{1i} + \beta_k w_{1k} + \gamma_k w_{2k}\, x_{2i}\}$$

where α_k, β_k, γ_k are parameters to be estimated.

x_{1i}, x_{2i} : variables relating to angler i, such as hours fished, years of experience

w_{1k}, w_{2k} : variables relating to species k, such as site location, historic catch rate, etc.

Given knowledge of the arguments of Q_{ik}, we can compute the expected number of fish caught per trip. One of the arguments is hours fished.

As an input into the contingent valuation model, we need expected daily catch of each of the four major species groups, big game, small game, flat fish and bottom fish. Specific versions of (2.1) are estimated for each species group. Because each species group is different, the specifications are different. The basic data used for each model are the same however. These observations come from merging NMFS intercept data, which has information on hours fished, and species sought and caught, with UMCP data, which has considerable information about tastes and skills of anglers. The data have been aggregated geographically from the NMFS sites, of which there are about 1,000 in the study area, to the 69 UMCP sites.

Merging NMFS intercept data with UMCP respondents provided us with 5,667 observations for the 69 sites throughout the nine states. This is less than the number of original interviews in Table 1.4, Chapter 1 because some of the respondents are not included in the analysis due to missing observations on experience or hours fished. An additional 1,449 of the 5,667 are omitted from the catch rate computations because these anglers reported that they were not seeking a particular species. Although considerable effort was made to estimate the fish caught of non-seekers, no model worked well.

Using the species groupings of Table 1.2 in Chapter 1, we classified each 'seeking' angler as seeking one of the four groups: big game, small game, bottom fish, or flat fish. Table 2.2 gives some descriptive statistics for each of the species groups used in the estimation of the Poisson model in 2.1. These are the number of fish that are caught by anglers who participate in the UMCP survey and who declared themselves to be seeking a certain species or species group. Almost forty percent are seeking small game (1,526 out of 4,156) and about a third seek flat fish (1,317 out of 4,156). A large proportion (882 of 1,317) of anglers seeking flat fish come from New York or New Jersey. Of the total respondents seeking big game, nearly 60% were intercepted in Florida.

Table 2.2 Descriptive Statistics for Species Group Sought

		SPECIES GROUP SOUGHT[a]			
		BIG GAME	SMALL GAME	FLAT FISH	BOTTOM FISH
NUMBER OF OBSERVATIONS		523	1526	1317	790
NUMBER CAUGHT PER TRIP	MEAN	.46	.83	2.44	4.48
	MIN.	0	0	0	0
	MAX.	16	9	51	70
STANDARD DEVIATION		1.18	1.56	4.33	8.24
COEFFICIENT OF VARIATION		2.59	1.88	1.77	1.84

[a]There are 67 anglers who were seeking the 'other' species group and anglers who reported they were targeting another big gamefish from shore. Both groups are not included in the analysis.

There is reasonable variation in catch rates. Bottom fish has the highest mean number caught and big game the lowest. The ranking of these means makes some sense, but must be judged carefully. As we show in the estimated models, the number caught per trip is systematically related to factors that vary by species. For example, the probability of catching fish is higher from boats, and almost all big game fishing takes place on boats. Further, big game fishing trips are longer. Hence, if we were to look at conditional means, (i.e. controlling for duration and fishing mode) the spread between big game and bottom fish would appear greater. The dispersion for bottom fish is much greater than for other groups, mainly because there are occasional very large catches. It is small for big game because the catch is clustered about zero and one.

2.2 ESTIMATING THE POISSON MODELS

In the following, we describe each of the Poisson models which explain the number caught per trip. The process of specifying these models is a blend of hypothesis testing and intuitively imposed prior restrictions. In each case we report only a single model, the results of which will be used in the estimation of the discrete choice contingent valuation model and the random utility model. The models are estimated using maximum likelihood techniques available in LIMDEP. We describe each model in terms of its conditional mean.

2.2A Big Game

The model estimated for big game is

$$Q_{i,BG} = \exp\{\alpha_{10} + \beta_{11}\,\text{SOUTH} + \beta_{12}\,CR_{BG} + \beta_{13}\,CR_{BG}\,PC_i\}$$

where

$Q_{i,BG}$ = number of big game fish caught by anglers seeking big game

$$\text{SOUTH} = \begin{cases} 1 \text{ if fishing occurred in the South Atlantic, that is, south of study area:} \\ \quad \text{North Carolina, South Carolina, Georgia, or Florida} \\ 0 \text{ otherwise} \end{cases}$$

CR_{BG} = historic catch rate of big game species at the site where the angler is intercepted.

$$PC_i = \begin{cases} 1 \text{ if party/charter fishing} \\ 0 \text{ otherwise} \end{cases}$$

These factors reflect the influence of region, species abundance, type of fish, and length of fishing trip on the number of big game fish caught. The estimated coefficients for this model are given in Table 2.3.

Table 2.3 Poisson Estimates for Big Game Catch Per Day

VARIABLE	MEAN OF REGRESSOR	COEFFICIENT (t-STATISTIC[a])
Constant	1.00	-1.35 (-8.01)
South	.77	.44 (2.47)
Historic Daily Catch (Big Game)	.61	.36 (4.99)
Party/charter × Daily Catch (Big game)	.15	-.29 (-3.48)
OBSERVATIONS CHI-SQUARED		501 1325

[a]Asymptotic t-statistic under the null hypothesis that true parameter is zero.

The coefficients are all significantly different from zero at the 95 percent level of confidence. The signs match prior expectations. The coefficient on the "South" states dummy variable is positive and significant suggesting that in this area, anglers are catching more than in other areas, even after adjusting for the historic catch rate.

For big game fishing, simply catching a fish is important. From equation (2.1) and the information in Table 2.3, we can compute 1 - $P_{BG}(0)$, the probability of catching at least one big game fish. These probabilities, together with mean catch rates, are reported in Table 2.4.

This table shows that the expected number of fish caught by all anglers seeking big gamefish is approximately equal to the probability of catching at least one fish. This illustrates the nature of big game catch. For any distribution, the expected catch is

$$E[Q] = O \cdot P(0) + 1 \cdot P(1) + \frac{2\,P(2)}{2!} + \ldots \frac{n\,P(3)}{n!}$$

If P(j), $j \geq 2 \approx 0$, then $E[Q] \approx P(1) \approx 1 - P(0)$, as is shown in the table.

Table 2.4 Predictions for Big Game Catch

Area	Probability of Some Catch[a]		Mean Catch[a]	
	Party/Charter	Private boat	Party/Charter	Private boat
North	.206	.234	.270	.323
South[b]	.276	.304	.420[b]	.502

[a] Assuming exogenous variables at their means.

[b] From North Carolina south, there are no party or head boats included.

From this table, the effect of effort in the boat mode is interesting. One expects party charter boats to produce a higher catch. After all, the angler gains the captain's experience. However, both the probability of catching big game and the mean catch are slightly higher for the private boat mode than for party/charter fishing. This probably relates to the type of big game the private boat anglers are seeking rather than the relative efficiency of the modes. Hired boats typically go for billfish whereas many private boats may seek wahoo, small tuna, or shark.

2.2B Small Game

The model estimated for small game reflects our experience and expectations concerning this activity. The model is

$$Q_{i,SG} = \exp\{\alpha_{20} + \alpha_{21}\,\mathrm{LOG}(HRS_i) + \alpha_{22}EXP_i + \beta_{21}\,PC_i + \beta_{22}\,CR_{SG} + \beta_{23}\,CR_{SG} * SOUTH\}$$

where PC_i and SOUTH are as defined for big game fishing and

$Q_{i,SG}$ = number of fish caught in small game group;

HRS_i = hours fished for angler i;

EXP_i = years of fishing experience for angler i;

CR_{SG} = historic catch rate of small game at the site where the angler is intercepted.

The parameter estimates for the Poisson for catching small game are given in Table 2.5.

The coefficients are all strongly significant and meet prior expectations. Extra hours spent fishing appear to have decreasing returns, although the coefficient is not significantly different from 1 (constant returns). Investing extra hours fishing for small game will pay off in extra catch, even on the shore. Fishing in southern waters seems to be relatively better than our historic daily catches reflect.

Table 2.5 Poisson Estimates for Small Game Catch Per Day

VARIABLE	MEAN OF REGRESSOR	COEFFICIENT (t-STATISTIC[a])
Constant	1.00	-1.77 (-10.31)
Ln (Hours fished)	1.49	.82 (7.76)
Experience	20.76	.007 (3.35)
Party/charter boat	.13	.51 (6.99)
Daily catch (Small game)	2.54	.028 (2.55)
South X Daily catch (Small game)	2.12	.035 (2.12)
OBSERVATIONS CHI-SQUARED		1,375 4,197

[a]Asymptotic t-statistic under the null hypothesis that true parameter is zero.

We can gain some understanding of the model for small game by computing the predicted mean catch by boat and shore in the two regions for experienced and inexperienced anglers. These mean catches are reported in Table 2.6. The predicted catch in this table is based on the mean historical catch rate of 2.54 and mean of the regressors given in Table 2.6 along with both

Table 2.6 Predicted Mean Catch for Anglers Seeking Small Game

AREA		MODE	
		Boat	Shore
North	Experienced[a] Inexperienced	7.00 2.09	4.18 1.22
South	Experienced Inexperienced	7.70 2.27	4.60 1.36

[a]Experienced defined as having more years fishing than the sample mean. Inexperienced is having the opposite.

region and experience. Our definition of "experienced" is simply having fished more years than the same mean. Anglers with more years than the sample mean averaged 31 years fishing whereas our "inexperienced" anglers averaged 11.5 years fishing. Predicted means show that the catch from shore can be expected to be slightly lower in the north than in the south. Also, one can obtain greater catch by having experience or by being on a boat.

2.2C Bottom Fish

The model for bottom fish is different than the big game or small game model. Bottom fish are sometimes less desirable and easier to catch than big game or small game. The bottom fish model is

$$Q_{i,BF} = \exp\{\alpha_{30} + \alpha_{31}\, LOG\, (HRS_i) + \alpha_{32}\, EXP_i + \alpha_{33}\, PC_i + \alpha_{34}\, CR_{BF} * EXP\}$$

where HRS_i, EXP_i, and PC_i have been defined and

$Q_{i,BF}$ = number of fish caught in bottom fish group;

CR_{BF} = historic catch rate of bottom fish at the site where the angler is intercepted.

The parameter estimates are given in Table 2.7.

Table 2.7 Poisson Estimates for Bottom Fish Catch Per Day

VARIABLE	MEAN OF REGRESSOR	COEFFICIENT (t-STATISTIC[a])
Constant	1.00	-1.17 (-10.67)
Ln (Hours fished)	1.52	1.20 (19.69)
Experience	21.10	.007 (5.35)
Party/charter boat	.80	.56 (9.21)
Daily catch (Bottom fish) × Experience	113.6	.0007 (7.30)
OBSERVATIONS CHI-SQUARED		564 9,793

[a]Asymptotic t-statistic under the null hypothesis that true parameter is zero.

The coefficients on the effort (LOG(HRS$_i$)), experience (EXP$_i$) and daily catch for bottom fish (CR_{BF}) crossed with the experience variable are all strongly significant and in accord with intuition. The coefficient on hours fished suggests slightly increasing returns. Thus, time fishing, availability of fish, and experience are factors influencing bottom fish harvest.

2.2D Flat Fish

The model for flat fish was by far the most difficult to design and estimate. There are several reasons for this. First, problems in aggregation of different flat fish arise. There are two main species: summer flounder (or fluke) and winter flounder. Much of the fishing for winter flounder is done in New York and New Jersey in the cooler months, and much of the fishing for summer flounder takes place in late summer or early fall from Maryland to Cape Hatteras. Consequently, the model must allow the historic catch rate to have a different impact in New York/New Jersey in the winter/spring than in summer, and to be different from summer flounder locations in other states.

To accomplish this end, we specify and estimate the following model.

$$Q_{i,FF} = \exp\{\alpha_{40} + \alpha_{41}\, LOG(HRS_i) + \alpha_{42} EXP_i + \beta_{41} CR_{FF} + \beta_{42}\, NYNJ^{*}CR_{FF} * \text{winter}\}$$

where

$Q_{i,FF}$ = number of fish caught in flat fish group;

CR_{FF} = historic catch rate for flat fish at the site where the angler is intercepted.

$$NYNJ = \begin{cases} 1 \text{ if fishing in New York or New Jersey during wave 1, 2, 3 or 6;} \\ 0 \text{ otherwise.} \end{cases}$$

The flat fish model is slightly different from the other models in that it accounts for a peculiar variation in the sample. As with the other models, we have the log of hours fished, experience, and historic daily catch of flat fish (Table 2.8). Unlike the other ones, we include a variable which interacts the historic daily catch with a binary variable showing whether the angler was fishing in New York or New Jersey in the winter or spring months. The interaction variable is meant to account for the difference between winter flounder distributions and other flounder distributions.

All of the coefficients are significantly different from zero and have the expected signs. There are slightly increasing returns to time in fishing. The coefficient on experience is approximately the same as with small game and bottom fish. The New York/New Jersey variable does indicate a significant positive effect for areas and periods during which winter flounder is available. This may mean that relative to the historic average (1980-88) winter flounder was more abundant in the 1988-89 period.

Table 2.8 Poisson Estimates for Flat Fish Catch Per Day

VARIABLE	MEAN OF REGRESSOR	COEFFICIENT (t-STATISTICS[a])
Constant	1.00	-1.90 (-11.91)
Ln (Hours fished)	1.56	1.17 (11.22)
Experience	22.60	.008 (12.52)
Daily catch (Flat fish)	4.00	.08 (11.22)
Daily catch (Flat fish) X New York/New Jersey × winter	1.34	.02 (3.13)
OBSERVATIONS CHI-SQUARED		1019 4686

[a]Asymptotic t-statistic under the null hypothesis that true parameter is zero.

These models are intuitively appealing. They capture a small degree of the great diversity of recreational fishing. As we shall see in Chapter 5, they do not always perform well in terms of predicting increments in catch. Their greatest virtue is the flexibility they provide in modelling restrictions on individual catch.

ENDNOTES

1. The difficulty with using catch rate defined on an hourly basis is that often respondents will not report hours fished or report it inaccurately. Because the fish caught variable is measured accurately, we have chosen to disregard the time dimension.

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Chapter 3
THE "CONTINGENT" VALUE OF ACCESS AND FISH

3.1 INTRODUCTION

In this chapter, the information on expected catch rates, as predicted by the Poisson, is combined with information from responses to contingent value questions in the UMCP interview. The resulting data are analyzed to yield economic values of access and sportfish enhancement. There are three major sections relating to 1) the annual values of access, 2) the two-month values of access, and 3) the value of changes in fish stocks. The annual values of access pertain to the general question of what sportfishing is worth to anglers and bear on issues such as long-term closures. The second is relevant to decisions where access could be limited to a short period of time, say because of an oil spill or because of short-term closures to protect a stock. Finally, the value of fish stocks relates more to enhancement, allocation or habitat protection issues.

We measure the value of East Coast marine angling with an analysis of a question asking anglers whether their rights of access to marine sportfishing grounds could be purchased from them. We use anglers' willingness to sell, as measured by the amount of money needed to buy their rights, as an indication of the economic value placed on access to marine sportfishing. This approach assumes that the anglers perceive themselves as having certain rights[1] to marine sportfishing. In the telephone interview, we present a contingent valuation framework which offers the respondent an amount of money to forego the right to sportfish in marine waters in a specified time and place. The amount of money is randomly varied across the anglers. We then correlate their choices of whether to accept or not with the bid and other factors which might influence the choice. Finally, the average amount of money necessary to obtain the access rights is computed.

3.2 THE QUESTION AND ITS ECONOMIC INTERPRETATION

The contingent valuation question in this chapter gives the angler the opportunity to trade hypothetically the fishing opportunity for money. When anglers accept the offer, then they reveal that the money is worth more than the opportunity. We hypothesize that the probability of acceptance varies systematically across wave and region because of the systematic variation in fishing opportunities, weather conditions and characteristics of the fishermen. For example, anglers fishing in New York in November and December are experiencing fishing and climatic conditions different from anglers in the South Atlantic during July and August. We would expect the temperature in New York to be unpleasantly cold, and hence relatively more people would give up their access in New York than in the South Atlantic region. However, this statement must be conditioned on the species' availability and abundance in each place during those months. Historically, winter flounder are particularly abundant during November and December on Long Island Sound.

In a more formal manner, we say that the anglers will agree to sell their access rights for the two-month period providing their welfare is improved with the payment (M) and without the fishing access. That is, accepting the offer implies they prefer the payment M to the right to fish for the proposed period (two months or one year). Mathematically, we represent the angler's utility function as

$$u_j(j, y; \mathbf{c}) = v(j, y; \mathbf{c}) + \mu_j \quad j = 0, 1 \tag{3.1}$$

where u(·) is the angler's indirect utility function and v(·) is the systematic portion of that function, j represents the choice to accept (j = 0) or reject (j = 1) the offer, y is angler's income level, and **c** is a vector of the characteristics associated with the individual and the particular fishing experience. The μ_j are random effects associated with the angler that arise because we are not able to consider all factors influencing the angler's response. The μ_j are assumed independently and identically distributed random variables with mean 0.

If the individual accepts the offer to give up fishing access for the proposed period, this implies that

$$v(0, y + M; \mathbf{c}) + \mu_0 \geq v(1, y; \mathbf{c}) + \mu_1 \tag{3.2}$$

and if he declines the offer, the inequality is reversed. Hence, the angler's response is a random variable with probability density

$$p_0 = \Pr\{\text{accept offer to forego saltwater fishing for a period}\}$$
$$= \Pr\{v(0, y + M; \mathbf{c}) - v(1, y; \mathbf{c}) \geq \mu_1 - \mu_0\}$$
$$p_1 = \Pr\{\text{reject the offer}\} = 1 - p_0$$

If we define η as $\mu_1 - \mu_0$ and let $F_\eta(\cdot)$ be the cumulative distribution function of η, then the probability of accepting the bid in exchange for access rights equals $F_\eta(\Delta v)$ where Δv is the difference in the deterministic portions of the indirect utility function between the two choices (that is $\Delta V = V(0, y + M; \mathbf{c}) - V(1, y; \mathbf{c})$).

There are a number of alternatives regarding the choice of functions for F_η and $v(\cdot)$. We have chosen a normal distribution for our error structure, F_η (see Hanemann (1984) for a discussion of the logistic and normal distribution in the context of binary choice). We have chosen a linear function for $v(\cdot)$ (see Sellar et al. (1985) for a discussion of its limitations)[2], so that

(3.3) $$v(j, y; \mathbf{c}) = \alpha_j + \beta y + \gamma_j \mathbf{c} \qquad \beta > 0.$$

Factors in **c** (e.g., boat ownership, fishing expenses, etc.) are assumed to control for heterogeneity in α_j across anglers. Thus, the coefficient, γ, is subscripted. The difference between the function, $v(\cdot)$, with access and without access is

(3.4) $$\Delta v = \alpha + \beta M + \gamma \mathbf{c}$$

where $\alpha = \alpha_0 - \alpha_1$ and $\gamma = \gamma_0 - \gamma_1$. This yields the probability model

(3.5) $$F(\Delta V) = \prod_{i=1}^{S_1} F(\alpha + \beta M_i + \gamma \mathbf{c}_i) \prod_{i=S_1+1}^{S} [1 - F(\alpha + \beta M_i + \gamma \mathbf{c}_i)]$$

where the set of individuals is ordered such that the first S_1 are those who accept the bid and S is the entire sample size.

The appropriate measure of value for access to saltwater sportfishing is the expected payment that would make the individual angler indifferent between having access to the saltwater fishing with no payment and receiving compensation (CV) for relinquishing his right to fish for the proposed period. Formally, this is (letting $\eta = \mu_1 - \mu_0$)

(3.6) $$E[CV] = E[(\alpha + \gamma \mathbf{c} + \eta)/\beta] = (\alpha + \gamma \mathbf{c})/\beta$$

Here CV is compensating variation for access to fishing. This measure of the individual's value of fishing access is that amount of money which, given the randomness in our understanding of the anglers' preferences, would create a 50% probability of acceptance of the offer.

3.3 SPECIFICATION AND ESTIMATION OF THE MODEL

Given the wide variety of fishing in the area, the value of access to fishing for East Coast anglers depends on factors which reflect the heterogeneous fishing activities. Individuals fishing from a pier in Miami during March are experiencing fishing different from a charter boat patron in Ocean City, Maryland in July. To the extent possible, our estimates of values should reflect this.

Responses to the CV question naturally reflect the nature of the services that the angler is giving up. There are two systematic variations in the length of the period—two months and one year—and two systematic variations in the geographical extent of the foregone services only within the state in which they were intercepted while others were asked to forfeit marine fishing in the entire Mid-Atlantic Chesapeake and South Atlantic (from New York through Florida). We consider the two questions within one analysis by using a binary variable (EC for East Coast) for whether the area considered was the entire area or the area within the intercepted state.

A secondary objective of this research is to obtain estimates of the value of enhanced or degraded sportfishing stocks, and it is essential that we consider the value as a function of different marine species and their abundance. Policies that directly enhance water quality or fish stocks are assumed to generate value or benefits to anglers. But without evidence of that link, it is difficult to justify the costs of such policies.

We use anglers' expectations of catch per day, developed in Chapter 2, as the vehicle through which the probability of acceptance is linked to historic abundance at sites. More precisely, for every angler we compute an expected catch per day fished. The specifications given in equations in Chapter 2 are used in conjunction with historic catch rates and hours fished in each state for the wave and mode during which the individual is relinquishing fishing access.[3] As an example of computing expected catch rate (Q), consider an angler who is intercepted while fishing for small gamefish from shore in Delaware during the May/June period. This angler is contacted at the beginning of the July/August period and asked whether he would accept an offer ($M) to give up fishing during July and August. To compute the expected catch of this individual, we use the average historic daily catches (from 1980-1988) and average hours fished for small gamefish by shore fishermen in Delaware during July/August. Since the example is seeking small game, only the small gamefish expected daily catch is used for this angler. This is calculated using equation 2 from Chapter 2. The contingent valuation question pertains to the two months (or an entire year) subsequent to the intercept trip in which the respondent told us what species was being targeted. However, this is the best information available on species sought and mode of fishing and provides a reasonable prediction. Finally, by taking the square root of the expected daily catch for the estimating equation, we imposed that the marginal utility of additional fish caught is restricted to be decreasing.

Other individual factors influence the contingent value decision in addition to the expected daily catch of species. If the angler owns a boat, he has additional opportunity costs from giving up marine fishing. Some boat owners might enjoy boating jointly with fishing and thus foregoing the fishing might lower their utility more than others. In addition, even if sportfishing were the sole activity, there are fixed maintenance/interest costs that are incurred and these might be perceived as additional losses from accepting the payment and relinquishing fishing rights. To account for these factors, we use the angler's estimate of his boat's value and classify it into three categories, less than \$10,000, greater than or equal to \$10,000 but less than \$60,000 and greater than or equal to \$60,000. Boat value also may represent a surrogate for angling avidity; higher values for boats may reflect stronger preferences for fishing. We also expect respondents with more fishing experience to have "roots" in marine angling and be reluctant to accept a bid. Thus, individuals' value of boat value (BV) and experience (E) are hypothesized to be negatively correlated with <u>their</u> likelihood of accepting any given bid. At the same time, the most mobile anglers are those intercepted on party/charter trips. The PC takes a value of one if the intercepted trip was in the party/charter mode. It is designed to test whether anglers on the party/charter mode differ in their responses.

The contingent valuation exercise is a novel experience for most respondents, so it is natural that some respondents were more confident of their answers than others. Respondents were asked to rank the sureness of their response (1 to 4 with 4 indicating the most confident). The subjective evaluation was then used as a prediction of the response to the question.

Another potentially important factor in their acceptance is the accessability of out-of-state substitute sites. Because we do not have information on these, no perfect control for them is possible. However, we can recognize that individuals intercepted in a state other than their state of residence have and use out-of-state sites. Moreover, accepting the bid, if it is not for the entire East Coast, does not preclude them from marine fishing in their resident state. To control for this factor, we create a dummy variable for anglers who were intercepted in their resident state. The variable (L) is expected to negatively influence the probability that a respondent will answer yes to a given offer to stop fishing in their state of intercept. This variable is also interacted with the East Coast dummy variable (EC) to control for whether the respondent was asked about the state of intercept or the entire East Coast.

The general weather patterns during the period in question also may be important. One might expect a rational individual to be willing to trade marine fishing for less money if the weather is unpleasant. We take the natural logarithm of the average temperature for the area as a surrogate for weather. This variable (LOGTEMP) not only reflects temperature conditions but other factors that systematically vary from north to south during those months.

The form of the estimated model is given by

$$\Delta v = (\alpha_0 - \alpha_1) + \beta M + \gamma_1 E + \gamma_2 S + \gamma_3 L + \gamma_4 EC + \gamma_5 EC*L + \gamma_6 PC + \gamma_7 LOGTEMP + \sum_{j=8}^{10} \gamma_j BV_{j-7} + \sum_{k=11}^{14} \gamma_k (Q_k)^{1/2} \tag{3.7}$$

where the mnemonics and exact definitions are provided in Table 3.2. The likelihood function is normalized on positive responses to the question. The expected signs of coefficients are shown in the table. When estimating the model and computing average willingness to sell, observations are weighted to account for the NMFS sampling scheme.[4] The model is estimated for responses for the two access questions: the question associated with relinquishing fishing rights from New York to Florida, and the question associated with relinquishing fishing rights in the state where the angler was intercepted.

3.4 ANNUAL ACCESS VALUES

Of our total sample, one-half were asked about their willingness to sell **annual** access rights. One-half of these respondents were asked, "If you were offered a check for $M to give up saltwater recreational finfishing for the year anywhere <u>in the state in which our field interviewer spoke with you</u>, would you accept it?" The other half of the respondents were asked the same question with "on the Atlantic Coast between New York and Florida" substituted for the underlined phrase. Thus, while about half of the respondents answered questions regarding the intercepted state, the other half received questions regarding their willingness to sell sportfishing access to a large portion of the East Coast.

An identical range of bids was offered in the annual question as in the two-month question. For the annual question, only about twenty percent of the respondents accepted the offer (Table 3.1), about one-half of the acceptance rate of the sample asked regarding two months. Our annual results are thus not likely to be as robust nor as reliable as the two-month values. However, the empirical analysis of the responses showed consistency and statistical significance from similar factors, irrespective of the length of severance from marine angling.

Table 3.1 Percent[a] of Sample Accepting Contingent Payment to Relinquish Fishing Rights for One Year, By State

REGION/STATE	PERCENT ACCEPTING	REGION/STATE	PERCENT ACCEPTING
MID-ATLANTIC	18	SOUTH ATLANTIC	20
New York	18	North Carolina	16
New Jersey	18	South Carolina	19
Delaware	20	Georgia	11
CHESAPEAKE	21	Florida (East Coast)	22
Maryland	21		
Virginia	21	ALL STATES	20

[a]The mean is a weighted mean, weighted to eliminate oversampling of anglers taking many trips and potential sampling bias. See endnote 4 in text. "na" means fewer than five anglers in the cell.

3.4A Probit Results for the Annual Access Question

The model described in equation 3.7 was estimated for respondents who considered bids for access to marine fishing from New York to Florida (Table 3.2). The signs of the coefficients were generally consistent with our expectations and ten of the fourteen coefficients were significantly different from zero at the 5% level.

Factors that were statistically significant (at 5% level) and negatively related to the likelihood of accepting the bid included experience (E) and the sureness of answer (S). The coefficient associated with relinquishing the entire East Coast (EC) was also negative and significant as was the coefficient for whether the respondent was intercepted in the state of residence (L). Although all of the estimated expected daily catch coefficients were negative, the big gamefish and flatfish catch rates were not statistically significant factors.

Table 3.2 Factors, Means and Probit Estimation Results, for Annual Willingness to Sell Access to Marine Waters

VARIABLE NAME (MNEMONIC) (EXPECTED SIGN)	DEFINITION	MEAN OF VARIABLE (S.D.)	ESTIMATED COEFFICIENT (T-RATIO)
Constant	Intercept of equation	1.0 (0.0)	-0.74 (-0.06)
Payment (M) ($\beta > 0$)	Money offered for two-month access	\$103.5 (144.6)	0.0022 (11.90)
Experience ($\gamma_1 < 0$)	Total years sportfishing	18.5 (13.4)	-.011 (-4.74)
Sureness of Answer (S) (γ_2 ' . 0)	Subjecftive repsonse concerning confidence in answer	3.90 (.39)	-.47 (-6.82)
Local (L) ($\gamma_3 < 0$)	Intercepted and resident state the same	.60 (.49)	-.17 (-1.99)
East Coast (EC) ($\gamma_4 < 0$)	Answer for East Coast fishing	.46 (.50)	-.38 (-3.76)
East Coast * Local ($\gamma_5 > 0$)	EC cross with L	.29 (.45)	.27 (2.17)
Party/Charter ($\gamma_6 > 0$)	Respondent intercepted on a party/charter trip	.19 (.39)	.32 (4.40)
Climate (LOGTEMP) (γ_7)	Log of average temperature	4.13	.29 (1.02)
Boat Value (BV1) ($\gamma_8 < 0$)	Value less than \$10,000	.24 (.43)	-.09 (-1.16)
Boat Value (BV2) $\gamma_9 < 0$)	Value between \$10K and \$60K	.17 (.37)	-.19 (-1.84)
Boat Value (BV3) ($\gamma_{10} < 0$)	Value greater than \$60K	.01 (.11)	.73 (1.86)
Square root of daily catch of big gamefish (Q_{BG}) ($\gamma_{11} < 0$)	Expected catch of big gamefish for anglers seeking them	.07 (.20)	-.02 (-0.10)
Square root of daily catch of small gamefish (Q_{SG}) ($\gamma_{12} < 0$)	Expected catch of small gamefish for anglers seeking them	.19 (.38)	-.18 (-1.99)
Square root of daily catch of bottomfish (Q_{BF}) ($\gamma_{13} < 0$)	Expected catch of bottomfish for anglers seeking them	.18 (.59)	-.13 (-2.07)
Square root of daily catch of flatfish (Q_{FF}) ($\gamma_{14} < 0$)	Expected catch of flatfish for anglers seeking them	.17 (.46)	-.08 (-0.97)

$\chi^2 = 2294$.
Sample size = 2453.

The factors positively influencing acceptance were the amount of the bid, the party/charter variable, and the East Coast factor interacted with the "local" variable. The bid coefficient had the most significance, a comforting result when examining willingness to sell. The party/charter effect suggests that these respondents may have more alternatives. The final estimated positive effect, γ_5*EC*L, suggests that when the question is asked about the East Coast, respondents residing in the intercept state had nearly the same acceptance rate as those from other states.

The boat value and temperature effects were not statistically significant. The low-valued boat owners were less likely to accept a bid but the effect was not statistically significant. The respondents may have reasoned that they would sell their boats. The temperature variable does not have as much variation and therefore may not have much effect on the response to an annual access question.

3.4B Estimated Willingness to Sell Access

Using equation (3.6) and the coefficients shown in Table 3.2, we estimate the willingness of anglers to sell annual access rights to marine sportfishing both for the East Coast question and for the individual state question. The welfare measure is the amount of money which makes the anglers indifferent between the monetary payment and maintaining their fishing rights for a year. Although the calculation is made for each individual, we also compute the mean for states within the sample area.

The mean values for each state are shown in Table 3.3. The East Coast question leads to larger willingness to pay, with an average of about $90 more for the entire area. The mean willingness to sell ranges from a high of $700 in New York for access to the East Coast to a low of around $500 in South Carolina for access to South Carolina waters only. Presumably the large out-of-state population, the lower percentage of boatowners, the large number of anglers not targeting species and the nature of the bid caused the lower value. Generally, the values in the Mid-Atlantic are quite high.

Also computed (Table 3.4) is the aggregate willingness to sell in each state. This value was computed by multiplying NMFS's estimate of anglers in 1988 by the mean value of willingness to sell within a state from Table 3.3. An important adjustment is made to the official NMFS estimated number of anglers in the South Atlantic. The NMFS sample does not include anglers on party or head boats in the South Atlantic. In the Mid-Atlantic and Chesapeake

Table 3.3 Average Willingness to Sell One Year of Access to Marine Sportfishing, By Area Relinquished and State, 1988/1989

STATE/REGION	ACCESS AREA		
	ENTIRE EAST COAST	STATE OF INTERCEPT	AVERAGE
MID-ATLANTIC	692 (6)	591 (6)	639 (5)
New York	700 (10)	604 (10)	651 (7)
New Jersey	694 (11)	579 (10)	633 (8)
Delaware	659 (12)	596 (13)	624 (9)
CHESAPEAKE	653 (8)	573 (9)	613 (10)
Maryland	682 (27)	550 (29)	617 (21)
Virginia	639 (16)	587 (11)	605 (9)
SOUTH ATLANTIC	652 (8)	573 (9)	611 (6)
North Carolina	640 (16)	571 (17)	607 (12)
South Carolina	670 (17)	538 (30)	594 (18)
Georgia	688 (28)	588 (19)	640 (16)
Florida (East Coast)	658 (10)	585 (12)	618 (8)
ALL STATES	566 (5)	575 (5)	618 (4)

[a]Standard error of mean in parentheses.

regions, 16% of our sample use the party/head boat mode. To adjust the South Atlantic figures, the NMFS estimate of anglers is increased by 16 percent. There is substantially greater variation across states in Table 3.4 for aggregate willingness to pay, compared with the means per angler, owing mostly to the large differences in the estimates of numbers of anglers. The east coast of Florida, for example, has nearly ten times the number of anglers as Georgia. As a result, even though Georgia has a relatively large average willingness to sell, its aggregate value is the smallest.

Table 3.4 Aggregate Annual Value of Saltwater Angling Access Based on Willingness to Sell, By State and Access Area, 1988-1989 (millions of dollars)

REGION/STATE[a]	ACCESS AREA	
	INTERCEPTED STATE	NEW YORK TO FLORIDA
MID-ATLANTIC		
New York	320.7	360.1
New Jersey	573.2	664.3
Delaware	125.0	138.4
CHESAPEAKE		
Maryland	523.2	649.9
Virginia	386.2	420.5
SOUTH ATLANTIC		
North Carolina	756.2	906.4
South Carolina	325.1	404.9
Georgia	77.1	90.3
Florida (East Coast)	1,206.6	1,355.0

[a]The numbers of anglers shown in the South Atlantic have been adjusted upward by 16% from the numbers reported in NMFS, 1989 because the NMFS sample does not include party and head boat participants.

We also get a sense of the importance of the saltwater fishing states from this table. Florida stands alone, with over $1 billion in annual access value. North Carolina's value of access approaches $1 billion. Maryland and New Jersey are next with over $600 million.

New York, Virginia and South Carolina have between $360 and $420 million of annual access value. Delaware and Georgia are smallest, with around $100 million annually.

3.5 ESTIMATES OF ACCESS VALUES FOR TWO MONTHS

About one quarter of the respondents were asked, "If you were offered a check for $M to give up saltwater recreational finfishing for the next two months anywhere <u>in the state in which our field interviewer spoke with you</u>, would you accept it?" The amount of money, M, was varied randomly from $5 to $500. Another quarter of the respondents were asked the same question with "on the Atlantic Coast between New York and Florida" substituted for the underlined phrase. About forty-three percent indicated that they would yield their rights for two months in exchange for the hypothetical payment.

The percent of acceptance in our sample varied by region and wave as shown in Table 3.5. The two greatest percentage acceptance rates occurred during the winter period in Delaware and Virginia. The lowest acceptance rate occurred in New York, Maryland and North Carolina during the May/June period. In general, the May/June period represented the lowest bid acceptance rate for all regions, probably due to the season's beginning, the good fishing and mild weather.

Table 3.5 Percent[a] of Sample Accepting Hypothetical Payment to Relinquish Fishing Rights for Two Months, By Region and Wave, 1988-89

WAVE ACCESS RELINQUISHED	MID-ATLANTIC			CHESAPEAKE		SOUTH ATLANTIC			
	NY	NJ	DE	MD	VA	NC	SC	GA	FL
May - June	19%	49%	35%	20%	25%	20%	25%	29%	44%
July - August	32%	39%	46%	34%	36%	29%	46%	21%	44%
September -October	48%	65%	59%	49%	49%	51%	38%	55%	35%
November - December	52%	48%	56%	59%	73%	57%	49%	29%	43%
January - February	46%	46%	73%	na	na	51%	42%	53%	39%

[a]The mean is a weighted mean, weighted to eliminate oversampling of anglers taking many trips and potential sampling bias. See endnote 4 in text. "na" means fewer than five anglers in the cell.

3.5A Probit Results for the Two Months Model

The results are reported in Table 3.6. The signs of the estimated coefficients from the probit model were consistent with our expectations. Twelve of the fourteen estimates are statistically significant at the 5% level. The bid again was a significant positive factor predicting a "yes" response and was not significantly different from the annual question coefficient.

For the significant coefficients, the magnitudes of the coefficients were remarkably similar to the probit estimates of the annual access question (Table 3.2). The major differences were that the temperature variable had the expected negative effect on willingness to sell, the constant was substantially larger (7.17 versus -0.07), and the coefficients associated with the fishing area given up variable (EC) were insignificant. Presumably, the greater variation in temperatures over a two-month period permitted isolation of the influence that extreme cold in the Mid-Atlantic has during the winter months. The larger constant indicates that, everything else equal, respondents are more willing to give up fishing for two months than for a year. Although the sign on EC is as expected, the insignificance of the coefficient is troublesome. It may indicate that anglers do not substitute greatly across states in the short run.

The coefficients for the expected catch variables were more significant than those estimated using the annual question. This probably relates to our assumptions that fishermen targeting one fish group and intercepted in one wave will be targeting the same fish in another wave or over the entire year. The two-month question only requires that the angler's target species group remain the same until the subsequent wave. The relative magnitudes of the coefficients even conform to our expectations, with the big gamefish expected catch having greatest effect and the bottomfish and flatfish having the smallest effects.

3.5B Estimated Willingness to Sell Access for Two Months

Using equation (3.6) and the estimated coefficients in Tables 3.6, we can estimate each anglers' willingness to sell his access rights to marine sportfishing for two months. Because the area given up was not a significant factor in determining willingness to sell, we have not estimated the value for the state intercepted and for the entire Mid and South Atlantic. Although the CV computation is made for each individual, we present central tendencies for states within the sample frame. The computed mean is adjusted for potential sampling bias inherent in our sample (see endnote 4). The mean and its standard error are shown for each state by wave. The

Table 3.6 Factors, Means, and Probit Estimation Results for Two-Month Willingness to Sell Access to Marine Waters

VARIABLE NAME (MNEMONIC) (EXPECTED SIGN)	DEFINITION	MEAN OF VARIABLE (S.D.)	ESTIMATED COEFFICIENT (T-RATIO)
Constant	Intercept of equation	1.0 (0.0)	7.17 (7.45)
Payment (M) ($\beta > 0$)	Money offered for two-month access	107.5 (141.4)	.0024 (12.26)
Experience (E) ($\gamma_1 < 0$	Years fished	17.9 (13.6)	-.012 (-6.09)
Sureness of Answer (S) ($\gamma_2 < 0$)	Subjective response regarding confidence in answer	3.91 (.36)	-.44 (-5.92)
Local (L) ($\gamma_3 > 0$)	Intercept and Resident State are the same	.62 (.48)	-.06 (-1.09)
East Coast (EC) ($\gamma_4 < 0$)	Question directed to New York and Florida	.54 (.50)	-.07 (-1.40)
Party/Charter (PC) ($\gamma_5 > 0$)	Dummy variable for Party/Charter fishing	.20 (.40)	.29 (4.38)
Temperature (LOGTEMP) ($\gamma_6 < 0$)	Log of mean temperature	4.14 (.11)	-1.31 (-5.95)
Boat Value (BV1) $\gamma_7 < 0$)	Boat value less than $10K	.19 (.39)	-.26 (-3.74)
Boat Value (BV2) ($\gamma_8 < 0$)	Boat value between $10K and $60K	.14 (.35)	-.30 (-3.89)
Boat Value (BV3) ($\gamma_9 < 0$)	Boat value greater than $60K	.01 (.01)	-.68 (-2.40)
Square root of big gamefish catch (Q_{BG}) ($\gamma_{10} < 0$)	(Expected daily catch of big gamefish for anglers seeking them)$^{1/2}$	.06 (.20)	-.61 (-4.07)
Square root of small gamefish catch (Q_{SG}) ($\gamma_{11} < 0$)	(Expected daily catch of small gamefish for anglers seeking them)$^{1/2}$	.18 (.36)	-.32 (-3.91)
Square root of expected daily catch of bottomfish (Q_{BF}) ($\gamma_{12} < 0$)	(Expected daily catch of bottomfish for anglers seeking them)$^{1/2}$	.18 (.57)	-.18 (-3.23)
Square root of expected daily flatfish catch (Q_{FF}) ($\gamma_{13} < 0$)	(Expected daily catch of flatfish for anglers seeking them)$^{1/2}$	.19 (.48)	-.11 (-1.87)
χ^2 Sample Size			3274 2,632

standard error of the mean arises from the variation among the catch rates and individual characteristics of anglers—not from the error inherent in our statistical analysis.

Figures 3.1 and 3.2 are provided to demonstrate graphically how the values change over the year. The values are also shown in Table 3.7. The greatest variation across states occurs during the May/June period, perhaps due to the variation in the types of anglers, the temperature differences, and the expected daily catches. As summer comes, the variation is largely eliminated, with two-month values ranging between $194 to $268 for the July-August wave and between $134 and $230 for the September-October wave. Values for the colder months from November through February are more dispersed.

To obtain a notion of how aggregate access values for states vary over waves, the average willingness to sell is multiplied by the estimated numbers of participants provided by NMFS. The aggregate values are shown in Table 3.8. While it is tempting to add these for a given state and compare them with the annual aggregate values in Table 3.4, we warn against it. An angler's willingness to sell access for an entire year is not likely to be equal to the sum of independent willingness to sell for each two-month period. For instance, giving up fishing for two months may be too short and costly for an angler to adjust to alternative activities. Hence the sum of each two-month period would be more than an annual value, a period during which the angler can find alternatives. On the other hand, some individuals might easily give up two months of fishing but be hard pressed to change their habits for a period as long as one year. There is greater intertemporal substitution with the two-month question. Thus, it is difficult to say how a sum of individual periods is related to the whole.

However, the estimated sum of two-month values for a state is consistently greater than the annual value for the state. Thus, our empirical observations suggest that first explanation is consistent with the data.

3.6 THE VALUE OF ENHANCED EXPECTED CATCH

The previous analysis allows us to analyze policy choices concerning abundance of fish. In particular, we found in sections 3.2 and 3.3 that the economic value of access depended on expected catch rates of anglers. We also know from Chapter 2 that the expected catch of anglers is dependent on the historic catch, our measure of sportfish availability at a site. In this section,

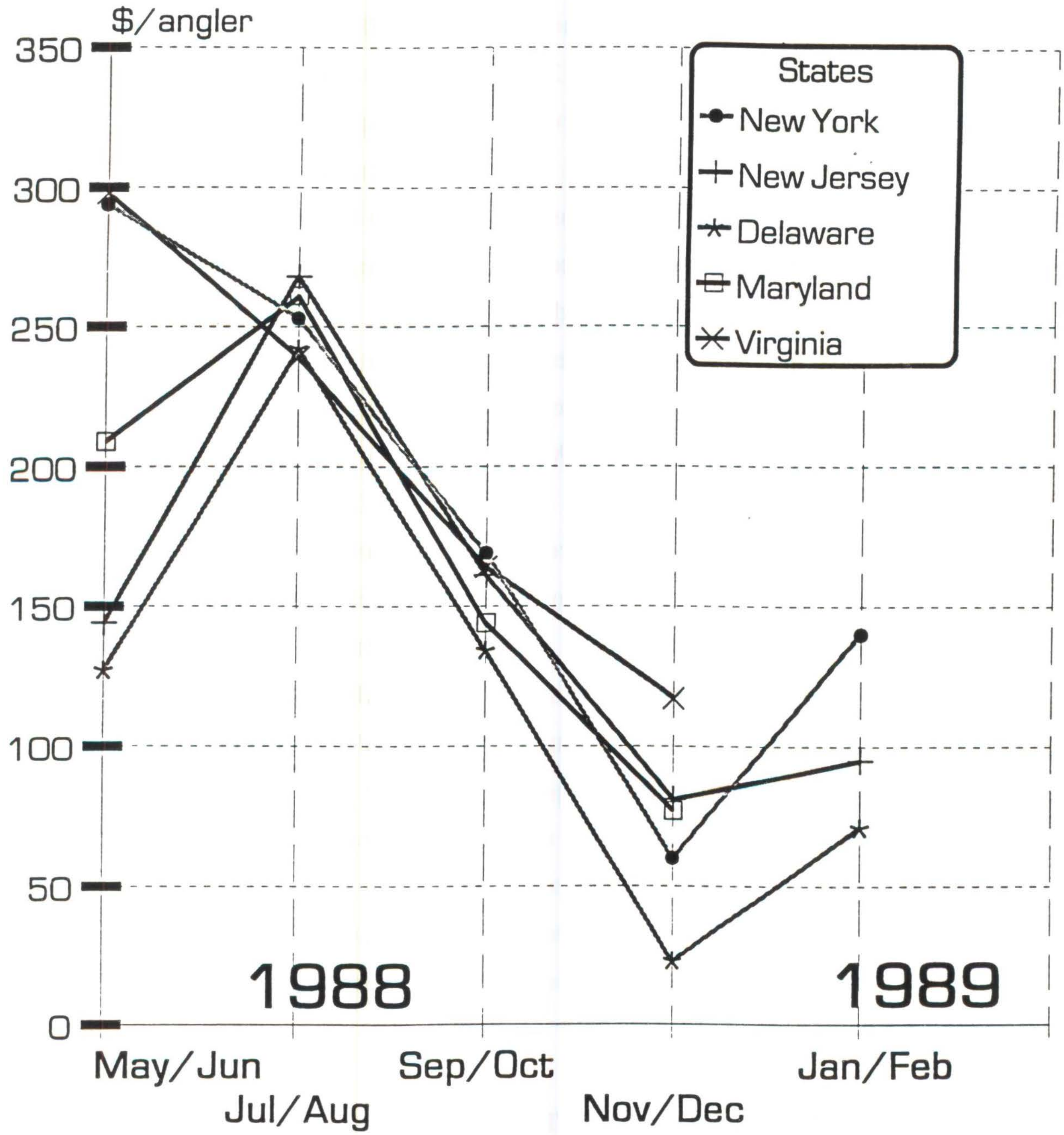

Figure 3.1 Average Willingness to Sell Marine Sportfishing Access for Two Months for the Mid-Atlantic, By Wave and State, 1988-1989

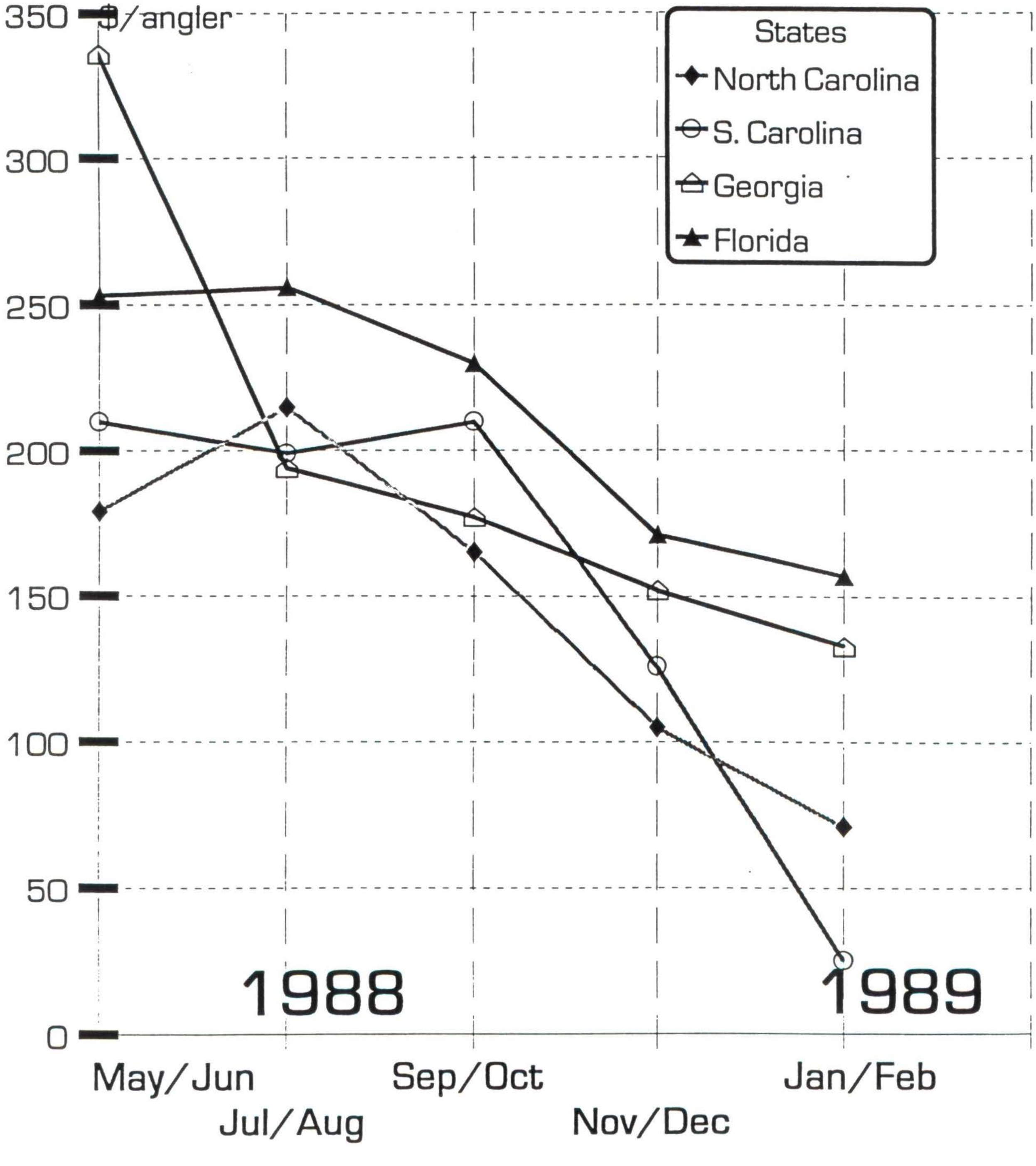

Figure 3.2 Average Willingness to Sell Marine Sportfishing Access for Two Months, For South Atlantic, By Wave and State, 1988-1989

Table 3.7 An Average Angler's Willingness to Sell Two-Month Access Rights, By State, Region and Wave, 1988-1989

	WAVE				
REGION	MAY/ JUN	JUL/ AUG	SEP/ OCT	NOV/ DEC	JAN/ FEB
MID-ATLANTIC	221[a] (17)[b]	258 (7)	158 (6)	67 (8)	115 (7)
New York	294 (20)	253 (13)	169 (9)	60 (13)	140 (9)
New Jersey	144 (62)	268 (8)	161 (9)	81 (13)	95 (17)
Delaware	127 (12)	242 (16)	134 (25)	23 (14)	71 (4)
CHESAPEAKE	238 (28)	249 (8)	151 (12)	83 (26)	3 (30)
Maryland	209 (43)	261 (16)	144 (18)	77 (65)	NA --
Virginia	298 (23)	239 (9)	164 (17)	117 (21)	NA --
SOUTH ATLANTIC	230 (9)	225 (9)	198 (9)	129 (10)	121 (17)
North Carolina	179 (20)	215 (17)	165 (16)	105 (19)	71 (17)
South Carolina	210 (10)	199 (28)	210 (47)	126 (47)	25 (66)
Georgia	336 (11)	194 (216)	177 (35)	152 (9)	113 (25)
Florida (East Coast)	253 (13)	256 (11)	230 (12)	171 (14)	157 (28)
ALL STATES	229 (8)	240 (5)	176 (5)	105 (7)	114 (11)

[a]Mean. [b]Standard error of mean, error associated with sample variation, not statistical estimates.

Table 3.8 Aggregate Willingness to Sell Two-Month Access Rights to Marine Waters, By State and Wave, 1988-1989

	WILLINGNESS TO SELL ($000,000)				
REGION	MAY/ JUN	JUL/ AUG	SEP/ OCT	NOV/ DEC	JAN/ FEB
MID-ATLANTIC					
New York	178	152	42	4	NA
New Jersey	92	198	50	8	NA
Delaware	17	47	8	0	NA
CHESAPEAKE					
Maryland	95	167	73	1	NA
Virginia	133	91	29	10	NA
SOUTH ATLANTIC					
North Carolina	123	164	93	18	1
South Carolina	68	56	70	16	NA
Georgia	23	13	9	5	4
Florida (East Coast)	180	272	130	128	193

NA—Not Available

we compute a new expected catch based on a change in the expected catch rate of one-half fish per day. We compute for each individual a willingness to sell with the new expected catch. The difference in each individual's willingness to sell is determined and averaged across the sample. The average for the anglers by state (or region) and species group is presented in Table 3.9 and a value aggregated over estimated anglers is given in Table 3.10.

The estimates in Table 3.9 should be used cautiously and conditionally. First, the values shown are derived only from individuals who were intercepted on a trip during which they stated they were seeking that species group. Nearly one-quarter of our sample (1449 of 5667) is not included in the values because they were not seeking any particular species or species group. These individuals undoubtedly do value improvements in availability of sportfish. States such as North and South Carolina have a large percentage of non-targetting anglers. Also, we define anglers as seeking a species group in a period (e.g., July/August) based on whether they were seeking the species in the previous two-month period (e.g., May/June). Finally, we determine their "expected" catch of the targeted species based on historic means. Clearly, these are "metaphors" for expected catch, meant to capture variation up and down the coast but not expected to provide perfect measures. For all of these reasons, we believe our estimates are biased downward. We are more interested in their systematic variation than in precise valuation. The random utility model in Chapter 5 is better for the latter purpose. Thus, we are not advocating the unconditional use of the actual values shown in Table 3.9 but rather believe that they have an informational content from their systematic variation across waves and states.

The values shown in Table 3.9 have several noteworthy characteristics. First, they are means per angler, not per trip. Thus, a casual fisherman has as much weight in the average as an ardent fisherman. Second, the values come from an indirect utility function which has the property of diminishing marginal value. The first fish is worth more than subsequent fish. Thus, if catch rates are relatively high, the marginal fish will be worth less than if they were relatively low. The values also reflect the proportion of anglers who were seeking that species group. A relatively high value may mean a high percentage of targeting anglers rather than a high value for a targeting angler.

Table 3.9 Average Two-Month Value/Angler of Increasing Expected Daily Catch By One-Half Fish Per Day, By Species Group and State

STATE OF INTERCEPT	BIG GAMEFISH ($/ANGLER)	SMALL GAME ($/ANGLER)	BOTTOM FISH ($/ANGLER)	FLAT FISH ($/ANGLER)	ALL FISH ($/ANGLER)
New York	3.87	5.90	1.57	3.31	14.65
New Jersey	1.19	5.68	1.08	3.38	11.32
Delaware	.21	9.55	.08	2.53	12.38
Maryland	4.06	6.95	.57	1.38	12.96
Virginia	3.55	5.04	1.45	1.23	11.28
North Carolina	4.85	3.73	.49	.44	9.50
South Carolina	1.35	5.59	.91	.88	8.73
Georgia	2.47	9.95	.75	.13	13.31
Florida (East Coast)	17.56	5.49	1.42	.12	24.60

The last column in Table 3.9 shows the value per angler of increasing all expected catch rates by .5 fish/trip. It ranges from around $10 to about $25. The big gamefish value is highest in Florida, perhaps reflecting the large percentage of anglers targeting big gamefish there. Small gamefish are most highly valued in Georgia (speckled trout), South and North Carolina (mackerel) and Maryland and Delaware (seatrout and bluefish; striped bass abundance was low during this period). New York and New Jersey have a predominance of value in flatfish anglers whereas Florida and Maryland anglers seek big gamefish. Bottomfish are important in New York, Virginia and Florida.

Table 3.10 The Total Value of Increasing Expected Daily Catch By One-Half Fish Per Day, By State and Wave, 1988-1989

	VALUE ($000,000)				
REGION	MAY/JUN	JUL/AUG	SEP/OCT	NOV/DEC	JAN/FEB
MID-ATLANTIC					
New York	4.7	9.6	4.6	.7	NA
New Jersey	4.8	11.3	2.9	1.0	NA
Delaware	3.2	4.5	.4	0.0	NA
CHESAPEAKE					
Maryland	5.6	11.3	8.0	.1	NA
Virginia	9.6	3.1	2.1	.6	NA
SOUTH ATLANTIC*					
North Carolina	4.8	5.7	4.7	1.6	.1
South Carolina	2.1	3.1	2.1	.8	NA
Georgia	.8	.2	1.1	.4	.4
Florida (East Coast)	12.6	20.0	11.7	11.8	35.6
ALL STATES	48.2	68.8	37.6	17.0	36.1

*Does not include party boat fishing in South Atlantic.

Aggregating the values of increased availability across species and participants (Table 3.10), using estimates of participants provided by NMFS, tends to highlight the areas and times of high fish value. The values show, based on the CV answers, the value of increasing expected catch by one-half fish for all groups of fish. Florida consistently has the greatest value, with over $10 million per wave. This value does not include party boats. Maryland, New Jersey and New York generate values around $10 million in the July/August wave. There are numerous wave/state combinations that record around $5 million in value of enhanced availability. The least value arises in Georgia, with only one wave generating more than $1 million. Taken as a whole, increasing daily catch across all species in July and August would generate nearly $70 million whereas the same increase in November and December would generate less than $20 million. These values, however, are meant to provide a backdrop for the more comprehensive analysis of Chapter 5.

ENDNOTES

1. The manner in which sportfishing groups opposed the imposition of marine angling licenses offers anecdotal support for the assumption. Moreover, the status quo does offer nearly free, unlimited angling for anyone who can access marine waters. There is a general feeling among contingent valuation researchers that willingness to sell questions may induce values which are too high. We used this question because anglers identify fishing rights as their own. Pilot tests, as well as others' experience, showed high proportions of refusals in the willingness to pay questions, which implicitly assign the fishing rights to others.

2. We have also used nonlinear forms of $v(\cdot)$ which include income as an argument. None of them was clearly superior to the form we have chosen here and in all cases, income was not a significant factor.

3. For full details of this function, see the previous chapter.

4. The weights are used because of the sampling bias associated with the National Marine Fisheries Service's Marine Recreational Fishery Statistical Survey. In the survey, people who make more frequent trips are more likely to be intercepted. Thus, if one is interested in a representative angler's willingness to sell, less weight must be placed on the more frequent anglers' value. This is done by dividing the total trips taken by anglers in a cell by the individual's reported trips. The weight for the i^{th} angler in the k^{th} cell is thus $\Sigma t_{ik}/t_i$, where Σt_{ik} = sum of trips over all anglers in all k and t_i = number of trips of i^{th} angler. To obtain the proper standard error of the mean using SAS, these values are normalized on the mean weight in a cell. In some cases, the cell represents state/wave combinations. However, weights are also computed for regions and the entire sample (all states).

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Chapter 4
VALUING TRIPS:
CONTINGENT VALUATION OF OVERNIGHT TRIPS

4.1 INTRODUCTION

In this chapter we investigate the implications of a contingent valuation question asked of respondents who were intercepted on a fishing outing which occurred during an overnight trip. An overnight trip is defined as a fishing trip during which the respondent was away from home for at least one night. Respondents in this category are anglers recruited in the same way by NMFS interviewers as respondents analyzed in previous chapters. They are distinguished by the fact that the respondents were fishing on a day that was part of a longer trip. It may be, however, that these anglers differed slightly in their motivation. The longer trip could have been for business, family vacation or other reasons only partially related to fishing.

The contingent valuation question concerns the value of a specific day of fishing. The kinds of issues that we can address with this contingent valuation question are more limited than those addressed in the previous chapter. In particular, we can only crudely aggregate the implied willingness to pay. More precise aggregation would require us to predict the multiple day trips, and fishing on multiple day trips. Despite the limitations in aggregation, we pursue the overnight contingent valuation question for what it reveals about willingness to pay per day. The overnight question is designed to estimate willingness to pay, not the willingness to sell. While our willingness to accept results from the previous chapter seem robust and reasonable, there is a predilection against asking willingness to sell in contingent valuation practice. We pursue the overnight contingent valuation because of the possibility that behavior on longer vacations is different from the one day fishing trip. This might be true if fishing were only an afterthought and the trip had an alternative principal purpose. In general, the problem of parcelling out welfare measures in settings with joint costs is not easily resolved.

Statistical comparisons of the relationship between the overnight contingent valuation and the access contingent valuation are difficult because the responses differ for several reasons. First, the overnight question addresses the respondent's willingness to pay and the day trip question addresses the respondent's willingness to sell. Second, the overnight question values a day at a site, while day trip question addresses access in a state for a period of time. Third, the overnight results are based on anglers whose principal reason for the trip may be unrelated to fishing. Fourth, the overnight question is ex post, while the access question is ex ante. Hence the only way to compare the results is to compare aggregate values, as is done in the conclusion.

The overnight contingent valuation question is asked of those anglers who took any overnight trips which included at least one fishing day during the two months' period during which they were interviewed. There are 1,399 people of the entire sample (5,374) who took fishing excursions which were part of longer trips. In the following analysis, we select only the people who were interviewed on the fishing occasion which took place on their overnight trip. The procedure includes 1,262 of the 1,399. This subset excludes people who took overnight trips but were intercepted on a day trip. We have chosen the ones who were interviewed as part of a longer trip because only that subset has recorded catch data. These actual catch data are used in the analysis.

The contingent valuation question was asked only of the first day of fishing on the overnight trip. There are ten questions on the details of the fishing, including mode, species sought, time, and costs of important fishing items. Following these questions, the respondent is asked

> If your costs for fishing on this day had increased by [a randomly selected amount of $5, 15, 30, 50, 75, 100, 150, 200], would you still have gone fishing?

The amount is varied proportionately and randomly over the eight cost increments. The interviewer records the response of yes, no, don't know, or refuses to answer. Note that this question is an ex post one and asks about a specific site at a specific time. Table 4.1 gives the proportion of responses in each category.

This table shows that almost 60 percent responded that they would still have taken the trip if their costs had increased. There is only one true refusal in the 'Refused No Answer' cell. The other four are problems with coding. We emphasize that this analysis is not a test of the contingent valuation method in general, or even the validity of our own version of contingent valuation. Rather, it is an attempt to deal with valuing fishing as part of multiple-purpose, multiple day trips.

Table 4.1 Distribution of Responses to Contingent Valuation Question

Response	Number	Percent
Yes	723	57.3%
No	487	38.6
Don't know	47	3.7
Refused/No Answer	5	0.4
Totals	1,262	100%

4.2 ESTIMATING THE MODEL

This contingent valuation question can be interpreted in a utility-theoretic framework, similar to the question of the previous chapter. Let $u(1, y; \mathbf{c})$ be the angler's indirect utility when he fishes, with y being income and c be characteristics of the angler and fishing occasion. Let $u(0, y; \mathbf{c})$ be the indirect utility available to the angler if he stops fishing, using the same definition for y and **c**. The angler will respond yes to the question if

$$u(1, y - A; \mathbf{c}) > u(0, y; \mathbf{c}) \quad (4.1)$$

where A is the cost increment stipulated in the question. The $u(\cdot)$ has a systematic and random portion and the systematic portion is a function including parameters which allow one to calculate various welfare effects. The goal of the analysis is to estimate these parameters.

When u is given the standard interpretation of these models, that is, it is deterministic to the respondent but random to the researcher, we can write it as

$$u(j, y; \mathbf{c}) = v(j, y; \mathbf{c}) + \varepsilon_j$$

where ε_j is a mean zero random error, typically specified as type I extreme value or as normal. As in the previous chapter, ε_j is assumed normally distributed. (In the binary choice case, there is little difference in results for the two distributions.) When u is viewed as random, the probability that an angler responds that he would pay the extra cost and continue fishing is given by

$$\begin{aligned}\text{Prob (continue fishing)} &= \text{Prob } (u(1, y - A; \mathbf{c}) > u(0, y; \mathbf{c})) \\ &= \text{Prob } (v(1, y - A; \mathbf{c}) - v(0, y; \mathbf{c}) > \varepsilon_0 - \varepsilon_1).\end{aligned} \quad (4.2)$$

Under the above assumptions, $\eta = \varepsilon_0 - \varepsilon_i$ is also normally distributed, and the yes/no response becomes a simple probit model, where the conditioning variables are y, **c**, and A. The exact nature of the model depends on the functional form of the v(j, y; **c**).

There are 1,262 observations which are matched with the NMFS intercept surveys. Table 4.2 gives the percent responding 'yes' across region and period. For the sake of comparison, the regions are defined the same here as in the previous chapter. However, the periods are arrayed somewhat differently. The contingent valuation question in this chapter is an ex post question, which asks about a fishing occasion during the two month period in which

Table 4.2 Percent of Anglers on Overnight Trips Who Are Willing to Continue Fishing with Higher Costs

PERIOD\REGION	MID-ATLANTIC[a]	CHESAPEAKE[b]	SOUTH ATLANTIC[c]
January/February	NA	NA	60.7% 9.4[d] 28[e]
March/April	50% 13.9 14	16.7% 11.2 12	58.1 5.1 93
May/June	58.8 7.0 51	48.0 7.1 50	54.0 4.3 137
July/August	64.8 4.7 105	53.5 5.0 101	65.8 3.7 164
September/ October	56.2 4.9 105	59.2 6.7 54	56.6 3.8 173
November/ December	35.3 11.9 17	60.0 24.5 5	55.3 5.1 94

[a]New York, New Jersey and Delaware.
[b]Maryland and Virginia.
[c]North Carolina through Florida.
[d]The second entry is the standard error of the percent.
[e]The third entry is the number who responded to the question.

the angler was originally intercepted. Hence for most states, there are no observations for wave one, except in the southern area, where interviewing occurred during January/February.

Table 4.2 illustrates some systematic variation in the affirmative responses. The rates are the highest March through October and tend to go down during the non-summer months. Where the weather is milder, in the southern region, the seasonal variation is less dramatic. There is no obvious variation among regions. Note that in several cells the numbers that appear to be outliers have few observations and large standard errors. For example, the mean percent plus or minus two standard errors for July/August in the South Atlantic is 58.8% to 73.2% while the mean plus or minus the standard errors for November/December in the Mid-Atlantic is 11.5% to 59.1%.

The responses in Table 4.2 are only roughly indicative, because they are averaged across respondents with different hypothetical increases in costs, and with different personal characteristics. To investigate systematic responses to the proposed cost increases, personal characteristics and fishing conditions, it is necessary to estimate the model proposed in equation (4.2) above. To estimate this relationship, we must first specify the functional form for $v_1 - v_0$ or Δv. When v( ) is nonlinear in income Δv remains a function of income. To estimate such a function, one must be able to measure income with some confidence. In our case, it requires interpolating income within ranges. Rather than use unreliable data on income, we assume that Δv is linear. This implies that the marginal utility of income is independent of income and constant with regard to other variables in the model. Our model for the utility difference is

$$\Delta v = \alpha + \beta A + \gamma c \tag{4.3}$$

where $\Delta v = v_1 - v_0$ and α, γ and β are parameters to be estimated, c is a vector of individual and fishing related variables, and A is the cost increment proposed by the interviewer that the angler would have to pay to continue fishing.

The variables for these models are

A = amount of hypothetical price increase proposed to angler;

BOAT = 1 if angler went fishing in the location where his boat was moored;

LOGTEMP = natural log of temperature, degrees fahrenheit;

F = 1 if the main purpose of the trip was to go fishing;

$QUAL = .61\ S_{bg}\ cr_{bg}^{1/2} + .32\ S_{sg}\ cr_{sg}^{1/2} + .11\ S_{wf}\ cr_{wf}^{1/2} + .18\ S_{bf}\ cr_{bf}^{1/2}$, where S_i is a dummy variable which takes the value 1 if the angler was seeking particular group i, i = bg (big game), sg (small game), bf (bottom fish), f (flounder), and cr_i is the angler's actual catch per hour on the day the interview took place, as recorded by NMFS interviewers;

$$QUALNS = .61\ cr_{bg}^{1/2} + .32\ cr_{sg}^{1/2} + .11\ cr_{ff}^{1/2} + .18\ cr_{bf}^{1/2}$$

where the q's are the actual catch per hour for each species group and QUALNS is calculated only for those not seeking a species (0 otherwise).

The number of specifications that could be estimated from (4.3) is quite large, and several were estimated. We have estimated a variety of models, with a representative specification which all roughly meet our a priori expectations concerning the size and significance of the effects. Table 4.3 gives parameter estimates for one model which will be carried through to welfare measures.

Table 4.3 Probit Model for Estimating the Response to the Question: "If your costs had increased by [A], would you still have gone fishing?"

Variable	Coefficient[a]	T-statistic
Constant	-1.21	-1.11
A	-.0077	-12.6
LOGTEMP	.470	1.83
F*QUAL	.684	1.95
BOAT	.321	1.66
F*QUALNS	.522	1.63
Chi-squared	1356	--
N	1202	--

[a]Under the null hypothesis that the coefficient equals zero.

These variables are meant to capture the effects of fishing conditions, the kind of trip, and the success on the trip. LOGTEMP is a measure of the weather. It is fixed by state and wave, so that an angler fishing anywhere in Florida would have the same temperature assigned for any day in the two month period of March and April. The variable F*QUAL represents a quality of fishing variable for people who planned to go fishing. It is computed from the actual catch that the anglers experienced on the fishing trip, as recorded by NMFS interviewers. The actual catch is converted to a catch per hour by dividing by hours fished. QUAL selects the square root of catch per hour at the species group sought and is weighted by the parameters on the respective individual expected catch rates in the discrete choice model estimated from the single day trips. That is, the coefficients .61, .32, .11 and .18 are estimated in the contingent valuation model used for the change in utility for the two month access question. (See Chapter 3, Table 3.2.) So, for example, if an angler went primarily for fishing and sought small game, F*QUAL would be .32 q_{sg}, where q_{sg} was the actual catch per of small game on the day of the outing. Note that F*QUALNS accounts for seeking and non-seeking anglers. If an angler is not seeking a species, and catches fish, QUAL is zero and QUALNS positive. If an angler seeks a species, QUAL is positive and QUALNS zero. If the angler catches no fish, both variables are zero.

The two boat mode dummies reflect different fishing modes, and thus allow for a different value of the experience. That is, we would expect that fishing on a boat would be a more highly valued experience than fishing from shore. However, the question is asked ex post, and, therefore, the responses may reflect differences in the realized trip from the expected trip. It is not clear that disappointment varies according to mode.

All of these estimated coefficients of the utility function have the expected sign; that is, the estimated effect of each argument on the probability of continuing to fish at a higher cost agrees with a priori expectations. The sign can be inferred from equations (4.2) and (4.3). The effect of an exogenous variable on the probability is given by

$$\partial \text{ Prob (yes)}/\partial c = [\partial \text{ Prob (yes)}/\partial \Delta v] \; \partial \Delta v/\partial c. \tag{4.4}$$

When the difference between fishing and nonfishing utility goes up, the probability of a yes increases. And anything that enhances the utility of fishing, such as an increase in the quality of fishing, will increase only the utility of fishing, and not the utility of non-fishing. Consequently, the signs of all the variables in each equation are as anticipated.

4.3 CALCULATING WELFARE EFFECTS

The coefficients of this model can be used to calculate the willingness to pay for some aspects of marine fishing. The approach is the same as in the previous chapter. We can solve the expression for the willingness to pay and then calculate the mean or the median. This equals the amount of money that would cause an angler to have a 50 percent likelihood of taking the fishing trip. In the case of a linear in income indirect utility function, these approaches yield the same answers.

For the linear specification in (4.3), the willingness to pay is the amount of money which makes utility equal in the fishing and nonfishing states. Including the stochastic terms yields

(4.5) $$A = -(\alpha + \gamma c + \varepsilon_1 - \varepsilon_0)/\beta.$$

If we assume that the only stochastic elements in 4.5 are the error terms, then the expected value of A is simply

(4.6) $$E[A] = -(\alpha + \gamma c)/\beta.$$

We use expression 4.6 for all the welfare calculations in this chapter. Note, however, that the actual distribution may be much more complex than the one derived by assuming that only the ε's are random. After all, the parameters are maximum likelihood estimates and asymptotically normally distributed. The actual distribution of A is quite complex and cannot be derived analytically.

Before digging into the numbers, let us review the analysis. The question analyzed in this chapter has several salient characteristics. First, it is essentially a willingness to pay question. Second, it is ex post, asking about a trip that took place up to two months prior to the phone interview. Third, it asks about a single fishing occasion which takes place on an overnight (or longer) trip. Because it is an ex post valuation, the angler probably conditioned his answer on the specific values of several random variables that were realized on the trip in question, for example, the state of the weather, the number and type of catch, the quality of companionship, etc. We have accounted for weather in using LOGTEMP. We have tried to account for the day's catch in the F*QUAL and F*QUALNS variables. Other realizations are simply part of the random error.

The fact that the contingent valuation question was addressed ex post, for fishing on a multiple day trip, may imply that substitution possibilities are ignored. The angler may not think about (as many) substitutes ex post, especially bundled within the longer trip scenario. If such is the case, answers might be higher than if the question were asked ex ante. It is possible that the angler could have gone fishing on another day of the multiple day trip, making the substitution easier, however. We have tested this hypothesis by separating the model according to whether the trip was one day or more than one day of fishing. There is no difference based on whether the trip was one or more days. Closely related is the purpose of the trip; we have partially controlled for this allowing the coefficient on the index of catch to influence willingness to pay only if the principal trip purpose is fishing. We have estimated a variety of other models which attempt to show the effects of different purposes for the trip. These too have shown no systematic differences.

We present estimates of the mean and median of willingness to pay by state and by wave. A given angler's mean and median are equal but the mean and median across anglers are not. That is, equation 4.5 can be computed for each angler in the sample. Its computation is based on the assumed distribution of the error term. But the mean of the individual anglers across anglers has an empirical distribution, in which the mean and the median (or other central tendency) may differ. For the two models (see Table 4.3), Table 4.4 gives mean and median willingness to pay for the first day of fishing on a multiple day trip.

Table 4.4 Willingness to Pay for a Fishing Occasion: Seasonal Variation

Wave	Mean	Median	Number in Sample
January/February	$5	$20	28
March/April	9	20	119
May/June	27	42	237
July/August	39	57	370
September/October	27	46	334
November/December	1.3	9	116

Several patterns are revealed by these measures. First, the two models predict quite closely. There is little difference between the means of the two models, and little difference between the medians. For simplicity in the future, we will present results only for Model One. The median is greater than the mean, typically, suggesting that the distribution is skewed.

The clearest pattern is the seasonal variation in willingness to pay. Willingness to pay rises from $5 in January/February to a maximum of $39 in July/August, the height of the fishing season on the East Coast and the most likely time for annual vacations. The willingness to pay then falls to about one dollar ($1.30) in November/ December. The seasonal variation is due to a variety of factors. The most obvious and probably the strongest factor leading to seasonal variation is weather. But there are other less obvious factors at work. The catch rates tend to be higher in the warmer months, suggesting greater stock densities during those months. This too leads to a higher catch rate through the QUAL variable. There are some confounding effects, however. The variable FISH, which tells whether a person went on the overnight trip with the main purpose of fishing, increases somewhat steadily (except for July/August) over the year from January/February to November/December. This has the effect of gradually increasing the mean or median willingness to pay over the year.

The value of access to marine recreational fishing should vary systematically over the season for obvious reasons. The results show this variation. However, if we examine variations across states, there are no a priori expectations. Of course, we expect fishing to be better in parts of Florida than in parts of New York, but not everywhere and not always. In Table 4.5, we show mean and median for willingness to pay for an overnight fishing trip, by state.

The values vary substantially by state from a low of $3 ($1 for the median) in Georgia to a high of $31 for Virginia. On an a priori basis, we would not have picked Virginia as having the highest valued trips. Nonetheless, the range of the means and the medians is not great. That is, the estimates lie roughly between ten to fifty dollars per day. And these estimates do not

Table 4.5 Willingness to Pay for a Fishing Occasion: Variation by State

STATE	Mean	Median	Number in Sample
New York	$26	$42	109
New Jersey	28	46	110
Delaware	30	45	73
Maryland	20	32	108
Virginia	31	53	114
North Carolina	26	34	360
South Carolina	21	52	86
Georgia	3	1	43
Florida	28	37	202

Table 4.6 Willingness to Pay for a One-half Fish Increase in Daily Catch: Seasonal Variation

Period	Mean over Sample	Sample Number
January/February	\$6.30	28
March/April	8.40	126
May/June	9.10	248
July/August	6.30	382
September/October	9.80	348
November/December	10.10	129

[a]The value for January/February is zero because none of the trips had fishing as their main purpose in this period.

change even when we try a variety of different models. The absence of any obvious logical variation in the willingness to pay must be partly explained by the nature of the trip. When people go on trips for several days, the fishing component may be less important than other aspects of the trip.

4.4 WELFARE EFFECTS OF CHANGES IN CATCH RATES

One of the variables which help determine willingness to pay for access is the catch rate of various species. It is important for us to consider it because various policies influence the catch rate. For pollution control, the argument is frequently made that improvements in water quality will improve fish stocks, which in turn make it easier to catch fish. Such an increase in catch rates can be brought about by fisheries policy also. For example, a policy to limit the catch of commercial fishing would increase fish density, leading to higher recreational catch rates. The effect of catch rates on overnight trips is modelled through the QUAL variable.

Recall that this variable was created from coefficients on the two months' access contingent valuation analysis of Chapter 3. QUAL is defined as

$$(4.7) \qquad QUAL = .61\ S_{sg}\ cr_{bg}^{1/2} + .31\ S_{sg}\ cr_{sg}^{1/2} + .11\ S_{wf}\ cr_{wf}^{1/2} + .18\ S_{bf}\ cr_{bf}^{1/2}.$$

In other analyses, we have found a direct and intuitive way of analyzing the catch rates. Using a Poisson such as estimated in the second chapter, we could change one of the factors that influence the number caught. However, for the overnight contingent valuation group, we have used actual recorded catch as in the equation above. To assess the impact of a change in catch conditions on anglers, we change QUAL or its components directly.

To compare with the previous analysis, the arguments of QUAL are increased, from their current values to one-half more fish per day. The change in the willingness to pay will be (based on eq. 4.6)

$$E[A^*] - E[A] = F\{(QUAL^1 - QUAL^0) + (QUALNS^1 - QUALNS)\}/\beta$$

where

$$QUAL^1 = .61\ s_{bg}(cr_{bg} + .5)^{1/2} + .31\ S_{sg}\ (cr_{sg} + .5)^{1/2} + .11\ S_{wf}\ (cr_{wf} + .5)^{1/2} + .18\ S_{bf}\ (cr_{bf} + .5)^{1/2}$$

or

QUALNS^1 is calculated with the same structure, except that the S_i, i = bg, sg, wf, bf terms are all equal to 1. QUALNS^0 and QUAL^0 are the actual or current values.

When the angler did not seek a species, QUALNS rather than QUAL is used. Note that for some anglers, the change in the catch rate will have no impact on their willingness to pay. This will be true if the principal purpose of the trip was other than fishing. The estimate calculated below is the welfare effect, averaged over the full sample. The table shows the mean willingness to pay for an increase in the catch rate at the site, for anglers on overnight trips. These numbers can be aggregated as follows. About 26% of all trips are overnight trips, based on our field intercept sample. Table 5.9 of Chapter 5 gives the total number of trips by wave and state. For example, for July/August, the mean willingness to pay per occasion is $9.10. There are about 3.2 million overnight trips (26% of 12.457 million). This makes the aggregate value of the increase in the catch rate about $29.1 million for the two month period. It does not allow for increases in activity; i.e., with higher catch rates there would likely be more trips.

4.5 A SIMPLE AGGREGATION OF BENEFITS

Accurately aggregating the benefits from the overnight contingent valuation question is difficult for a variety of reasons. First the fishing occasion is nested in a longer trip which may not be taken for the purpose of fishing. Second, the question was asked only for fishing on the first day of the overnight trip. Hence there is no way to aggregate across days or trips for a given angler. There is nevertheless useful information that can be gleaned from the overnight contingent valuation analysis.

This estimate of the welfare effects is quite high not because the model has unreasonable coefficients, but because a .5 increase in all species is a substantial increase in catch. For example, for QUALNS it produces almost a 400% increase. This occurs because many anglers caught no fish, and so a .5 increase is substantial. For the sample, for big game, small game, bottom fish and flat fish, the percent catching <u>no</u> fish were 93.7%, 81.2%, 77.7% and 88.3%. It is clear, then, that a .5 increase in fish caught is a substantial increase.

To aggregate to the fishing population, we make two simplifying assumptions:

1. The benefit of fishing for the two-month period in which an angler is interviewed is a good estimate of what he would pay for the fishing occasion times the number of days taken during the two-month period exactly like the one in which he was intercepted.
2. The proportion of anglers taking overnight trips in the population equals the proportion in our sample.

The first assumption is made because we cannot easily aggregate across trips. If we assume that the fishing occasion on which the intercept occurred was a randomly chosen intercept, then the values may be greater or less than the average value. To multiply the value obtained per trip by the number of trips may impart no direct bias. The assumption on the proportion of anglers is a necessity, because NMFS does not keep statistics on single day vs. overnight trips.

Using these two assumptions, we can derive a lower bound estimate of the willingness to pay for access for anglers who take a least one overnight trip. As in the previous chapter, we must deal with the two month vs. annual participation problem. We know the participation rate by state on an annual basis only. Hence we get a lower bound by assuming that each angler fishes only in one two month period. The lower bound for total willingness to pay for access is

Total willingness to pay =

(Mean willingness to pay for the intercepted occasion) *
(Number of similar trips) * (Number of anglers in 1988) *
(Proportion of overnight trips).

These calculations can be made by state because NMFS gives the total number of anglers participating in any state (**Marine Recreational Fisheries Statistics Survey, Atlantic and Gulf Coast, 1987-1989**, Table 32). Rather than taking all trips, we take the number which are similar to the one on which the contingent valuation question was asked. That is, in the telephone interview, the angler is asked "How many of the days you went finfishing on this overnight trip were like the one you just described in terms of type of fishing?" The estimates of the total are in the last column of Table 4.7. They are very conservative estimates of the willingness to pay for access for overnight trips.

The estimates in Table 4.7 are low in that they refer to the activity of only one two month period, and then only if the trips are similar. Perhaps the least reliable component of this estimate is the proportion of total trips which are overnight trips, the second column. This figure comes from the UMCP survey, but the survey was not designed to estimate this proportion.

Table 4.7 Estimates of Willingness to Pay for Access: By State for Overnight Trips

STATE	Mean willingness to pay[a]	Proportion of anglers intercepted on overnight trip	Number of anglers (1000's) (NMFS estimate)	Total willingness to pay ($000,000's)
New York	78	.130	485	4.9
New Jersey	176	.127	949	21.2
Delaware	140	.199	210	5.9
Maryland	68	.278	953	18.0
Virginia	91	.215	658	12.9
North Carolina	82	.471	1,306	50.4
South Carolina	70	.251	521	9.2
Georgia	13	.179	113	.3
Florida	143	.142	1,778	36.1

[a]This is the mean of the product of willingness to pay per occasion times the number of like occasions for the two-month period.

4.6 SUMMARY

In this chapter we have explored the contingent valuation question which relates to a fishing occasion which is part of a longer trip on which the angler spent at least one night away from home. In contrast to the previous chapter, the contingent valuation question is a willingness to pay question, and it is addressed not as an ex ante value of access but as an ex post value of a fishing occasion. Despite the differences, the analysis of this contingent valuation question yields answers which are reasonable in several ways. First, the functions estimated meet certain a priori expectations. The statistical significance of the cost increase is quite high. Second, the magnitude of the amount an angler is willing to pay, in the range of ten to fifty dollars per occasion, seems reasonable and is in rough conformity with other literature on this topic. Third, the variation of willingness to pay across seasons, and to a lesser extent across states, makes sense. Anglers pay more when the chances of catching fish are higher, they would pay more if the weather is warmer, and they pay more if their fishing experience is from a boat mode. Finally, the aggregation of these per occasion values to total fishing values under a set conservative assumptions leads to total fishing values by state which are lower bounds for fishing on overnight trips.

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Chapter 5
ESTIMATING THE RANDOM UTILITY MODEL: BEHAVIORAL VALUES OF ACCESS AND FISH

5.1 INTRODUCTION

In previous chapters, estimates of economic value for access to sites, for overnight trips, and for enhanced fish availability have been based on responses to contingent valuation questions. In this chapter, we estimate economic values based on revealed preferences of anglers sampled in the UMCP survey. We adapt a behavioral model of sportfishing to our sample and purposes, and we estimate parameters which describe anglers' responses to changes in expected catch rates, boat ownership, travel cost and travel time. From these parameters, we calculate willingness to pay for fishing trips and for increased fish per trip. Estimates from individual willingness to pay per fishing occasion are aggregated to the state level, by wave and annually.

5.2 THE RANDOM UTILITY (RUM) MODEL

Because of the regional nature of our project and the mobility of anglers, the model must be capable of considering a large array of alternatives available to anglers. Considering one site in isolation ignores the substitutions which will surely take place in the pattern of recreational use decisions. Approaches which do not effectively handle substitutes miss the essence of valuation. Kling (1986) compared several models which could be used to value quality changes in a simulation experiment in which true surpluses were known. When frequent substitution among sites characterized the true situation, the RUM model's value estimates were most accurate.

To see how the random utility model is structured, consider an individual's decision process. The RUM explicitly models the choice among substitute alternatives on a given choice occasion, where each occasion is assumed independent of the others. The choice is modeled as a function of the characteristics of the alternatives. The random utility model departs from the standard framework by considering decisions on a particular choice occasion. It does not incorporate features to evaluate the angler's behavior over a longer period of time. However, Parsons and Kealy (1994) and Morey (1994) have developed models which integrate the decisions of when to take trips and how many trips to take.

It stands to reason that an angler simultaneously decides to go fishing, to seek a particular species and to use a particular mode of fishing. From the newspaper, tackle shop, talking to other anglers or by recalling past experiences, anglers form expectations of a sportfishing trip. Initially, we assume that the angler has decided to go fishing and so do not model that decision. The remaining decisions are where to fish and under what circumstances. This is an assumption of necessity, because all of our observations are of anglers. We model the remaining decisions as a sequence of choices. We assume that an angler first decides to go fishing, then chooses the species and mode to fish. Finally, the angler chooses a site.[1] *A priori*, none of these choices is independent of the others. The fishing mode one chooses may preclude certain species from being caught, and the area of fishing may be accessible only with certain modes. Mode and/or target species alternatives may vary with region. Additionally, the alternatives may be different for different individuals.

We model the angler as first choosing the mode and target species and then, conditioned on this choice, choosing the site. These decisions can be separated because of the structure of the utility function. The indirect utility function for an angler is represented by

$$v_{ims} = \beta z_{ims} + \gamma w_{ms} + \varepsilon_{ims} \tag{5.1}$$

where z_{ims} is a set of attributes for the ms^{th} mode/target species at the i^{th} site, and w_{ms} is a set of variables which vary only with mode and species. This model is consistent with the nested logit as developed by Domencich and McFadden (1975) and McFadden (1978) [see Hanemann (1978); Morey (1987); and Bockstael, Hanemann, and Strand (1986) for applications to recreation].

When the errors, ε_{ims}, have a generalized extreme value distribution, and the choices are made by maximizing utility, the probability of choosing site i, conditioned on mode/species *ms* is

$$\text{Prob}(i|ms) = \exp\left[\frac{\beta z_{ims}}{(1-\sigma)}\right] \Big/ \sum_{j=1}^{n_i} \exp\left[\frac{\beta z_{jms}}{(1-\sigma)}\right] \tag{5.2}$$

where n_i is the number of sites for the ms^{th} mode species. This is a conditional logit for choice among sites. It is estimated first to obtain estimates for $\beta/(1 - \sigma)$. The probability of choosing the mode/species combination *ms* is then given by

$$\text{(5.3)} \qquad \text{Prob}(ms) = \frac{\exp[\gamma w_{ms} + (1 - \sigma) I_{ms}]}{\sum_{j=1}^{n_{ms}} [\gamma w_j + (1 - \sigma) I_j]}$$

where n_{ms} is the number of mode/species combinations. The variable, I_{ms}, is called the inclusive value and serves to capture the information about the site alternatives from the site choice stage. It is defined as

$$\text{(5.4)} \qquad I_j = \ln \left\{ \sum_{k=1}^{n_i} \exp\left[\frac{\beta z_{kj}}{(1 - \sigma)} \right] \right\}$$

Domencich and McFadden show that when σ equals 0, the problem reduces to a simple multinomial logit with $n_{ms} * n_i$ alternatives, and no independence of irrelevant alternatives violation arises. When $\sigma = 1$, the site alternatives within each mode/species sub-group are perfect substitutes for one another, and the only non-trivial decision problem is that among mode/species. The term $1 - \sigma$ is estimated as the coefficient on the inclusive value in the second stage of the model. Estimates of β require an estimate of $1 - \sigma$, because the first stage parameter estimates are $\beta/(1 - \sigma)$.

In applying random utility models to recreation systems, we model the decision per choice occasion and this leads to an additional limitation of the model. Because our discrete choice model explains decisions among discrete alternatives, it is structured so that each trip is a mutually exclusive event. From a practical standpoint, this simple model is satisfactory, because the direction of bias is known and likely to be small for most applications. Nevertheless, it challenges economists to close the conceptual gap, and there have been several such efforts. These efforts require richer data sets or stronger, more ingenious assumptions. Utilizing a carefully designed data set, Carson, Hanemann, and Steinberg (1988), in their study of sportfishing in Alaska, collected data per week using a diary method and limited data collection to those weeks in which relevant fisheries were open. The authors then used discrete choice to model a sequence of decisions: (1) Did the individual fish in the week period? (2) If he fished, did he go once, twice, more than twice, etc.? In that study, the choice occasion was a week, and the potential number of trips was small enough so their set could be treated discretely. Conceptual advances are illustrated by Parsons and Kealy (1994) and by Morey (1994), who have recently made progress in developing models to handle the quantity and distribution of trips.

In the model below, we provide a set of estimates of welfare measures calculated on a per choice occasion. These estimates do not account for possible changes in the number of trips from changes in circumstances. The welfare measures that are calculated are per choice occasion. If the changed circumstance to be valued is not likely to change the number of choice occasions (i.e. sportfishing trips, in this case) but only to change their allocation across mode, target species, and site alternatives, then this welfare measure is quite adequate. However, if the change in circumstances is great enough to induce substantial changes in the number of trips taken, then the welfare measure will underestimate the effect of an improvement in circumstances and overestimate the effect of a decline. Hanemann (1978), Bockstael, Kling and Hanemann (1986), Hausman, Leonard and McFadden (1992) and Parsons and Kealey (1994) have incorporated trip demands by estimating a demand for trips model. To compare the estimates derived from the constant trip assumption, we develop a model of the demand for trips as a function of the inclusive value, among other variables. This model, which is satisfactory in most pragmatic aspects, converts the unit of analysis from representative trips to individuals and hence requires estimates of the number of anglers for aggregation.

5.3 THE DATA

The data for the analysis came from the survey discussed in Chapter 1 (the interview instruments are shown in Appendix C). The UMCP survey obtained information regarding each respondent's unique day trips in the South and Mid-Atlantic during the two-month period. Specific information on each unique day trip and on specific demographic information is discussed in Chapter 1. Irrespective of the estimation method, studies of microbehavior (and especially studies of sportfishing) require difficult and, to some degree, arbitrary aggregation decisions. As discussed in Chapter 1, the data are aggregated over fishing mode, fishing site and targeted species. To the degree possible, sites (i.e., trip destinations) are aggregated to the county level but some cases required greater aggregation and some less. The sites are listed in Table 1.2. This aggregation is not expected to cause serious specification problems for shore fishing because the fishing sites within the aggregated counties are relatively homogeneous. It is difficult to define sportfishing sites, whether aggregated or not, for boat anglers. We typically know where the boating angler moored or launched his boat but not where he actually fished.

We continue our five classifications of fish: big game (e.g., billfish, marlin, and tuna), small game (e.g. bluefish, mackerel, and sea trout), bottom fish (e.g. croaker, and snapper), flat fish (e.g. winter flounder, summer flounder, fluke) and non-target species. We aggregate the mode of fishing to shore, private/rental boat and party/charter boat. The mode/species combinations are shown in Table 5.1. One combination, big gamefish/shore, is not considered a feasible choice and is deleted.

Table 5.1 Mode/Species Combinations, Mnemonics, Proportion of Total Trips

Mode	Species Group	Mnemonic	Proportion of Total Trips
Party/Charter	Big gamefish	PCSG	.017
	Small gamefish	PCSG	.051
	Bottom fish	PCBF	.037
	Flat fish	PCFF	.040
	Not targeting	PCNT	.029
Private/Rental	Big gamefish	PRBG	.090
	Small gamefish	PRSG	.194
	Bottom fish	PRBF	.058
	Flat fish	PRFF	.138
	Not targeting	PRNT	.117
Shore	Small gamefish	SHSG	.076
	Bottom fish	SHBF	.021
	Flat fish	SHFF	.038
	Not targeting	SHNT	.087

We have referred to the problems with establishing species groups in several places but the problems are most apparent in the RUM model when considering big gamefish. The variety of species, from sailfish to sharks, varies systematically across the area of study. New York and New Jersey anglers in the private rental mode seeking big gamefish fishing most often target sharks whereas big game anglers in the private rental mode target sharks, tunas and dolphin in all states. Party/charter boats from Delaware through North Carolina target tunas while south of Virginia, billfish (e.g. sailfish and marlin) are more predominant. Three expected catch variables were created to cope with these problems:

(1) catch rate of big gamefish,

(2) catch rate of big gamefish × party charter × (DEL + MD + VA + NC), and

(3) catch rate of big gamefish × party charter × (NC + SC + GA + FL).

(The notation DEL + MD + VA + NC means that the angler was intercepted in one of these four states.)

The Poisson model of catch developed in Chapter 2 provides expected catch for each individual at each of the aggregate sites. The predictions of expected catch use average hours fished at each site (from the 1980-89 NMFS sample). For anglers not seeking a species, the average expected catch of small game for the appropriate mode is used as the site quality variable.

The Poisson model provides an intuitively appealing model of the relationship between fishing effort and catch. However, its predictions of catch in response to increases in the historic catch rate are occasionally quite small, leading to low estimates of the value of additional fish. As an alternative, the RUM model is estimated completely on the basis of the historic catch rate.

The exogenous variables used in this model are similar in many respects to the other models presented in Chapters 3 and 4. The wide geographic coverage of the model, coupled with the use of NMFS intercept survey for quality variables entailed a massive amount of programming. These variables are described in Table 5.2.

5.4 MODEL ESTIMATION

In the models below, we describe the estimation and welfare measure of two models. The first is the model based on using the expected catch, as predicted by the Poisson. The second has the same specifications except that the mean historic catch rate is substituted for expected catch. The two stage estimation process is identical for both models.

The model presented in Eqs. 5.2 and 5.3 was estimated using the data described above. The estimation was accomplished in two stages: the first stage models the choice of site conditioned on mode/species, and the second stage models mode/species choice. The sixty-nine

Table 5.2 Definition of Variables

TC:	Travel cost = \$.20 × distance + wage × time × interior distance: roundtrip distance from Hiways and Biways files; wage: self-reported; if not, predicted from estimated equation interior: dummy equaling 1 if person can work extra hours for extra pay, 0 otherwise: time: roundtrip travel time, predicted from equations estimated from self-reported time and Hiways and Biways distance
TT:	Travel time = time × (1 - interior) time: roundtrip travel time as described for TC 1-interior: dummy variable taking a value of 1 for persons unable to work extrahours for extra pay, 0 otherwise;
M:	Size variable: This variable is the number of interview locations in the NMFS intercept survey in the UMCP site. Obtained from NMFS.
FL:	A dummy variable with value 1 if a site is in Florida, 0 otherwise.
STH:	A dummy variable with value 1 if a site is south of Virginia, 0 otherwise.
Q:	The catch as predicted from the Poisson model of Chapter 2.
SH:	A dummy variable with value 1 for the shore mode, 0 otherwise.
P/C:	A dummy variable with value 1 for the party/charter mode, 0 otherwise.
P/R:	A dummy variable with value 1 for the private/rental mode, 0 otherwise.
B:	A dummy variable with value 1 for the site at which the angler has a boat moored, 0 for other sites.
DMVNC:	A dummy variable for states from Delaware south through North Carolina.
BG:	A dummy variable with value 1 if the angler is seeking big gamefish, 0 otherwise.
SG:	A dummy variable with value 1 if the angler is seeking small gamefish, 0 otherwise.
BF:	A dummy variable with value 1 if the angler is seeking bottomfish, 0 otherwise.
NS:	A dummy variable with value 1 if the angler is not seeking a species, 0 otherwise.

sites are the county groups in Appendix A. The fourteen mode-species choices are shown in Table 5.1. Because each mode/species choice is viable for all sixty-nine sites, there are 966 (= 14 × 69) distinct alternatives if all sites are considered. However, since our sample was only one-day trips, all 69 sites were not considered available for each angler.

5.4A First Stage Estimates

The definition of the site choice influences parameter estimates and hence welfare measures. Obviously for single day trips, each individual does not have access to all 69 sites. The choice sets are determined in the following way. Using mileage from Hiways and Biways, we calculate the shortest distance from a person's residence to any site of the 69 sites. If the closest site is less than 30 miles away, then we assume the person's choice set is limited to sites within 150 miles. The logic is that anglers who live close to one site also live close to the shore and will consider a more limited set of alternatives than people who live further from the coast. For people who live more than 30 miles from the nearest site, any site within 400 miles is a relevant choice. Even when these criteria are used, many choice sets include 50 sites.

To make the estimation process tractable, we randomly sampled seven sites from each choice set (see Parsons and Kealy, 1992, for a sensitivity analysis of this procedure). Six were chosen randomly and the actual chosen site was included. If the original choice set contained seven or fewer sites, no random selection occurred.

We specify the following general model:

$$v[\text{site}(i) \mid \text{mode/species (ms)}] = f(TC_i, TT_i, \ln(M_i), \text{REGION}, \sqrt{Q_{i,ms}})$$

where the variables are defined in Table 5.2. The "REGION" variable refers to a variety of indicators which change the site choice acording to location. The specific structure varies by mode, and can be seen in detail in Table 5.3. The square-root of the expected catch, $\sqrt{Q_{i,ms}}$, as estimated in Chapter 2, is determined for i^{th} site and the specific mode/species combination chosen. Thus, the site choice for an angler who has chosen to use a private/rental boat and is seeking small gamefish becomes a function of his expected catch of small gamefish using the private/rental mode of fishing at the sites in his choice set. The square-root transformation ensures the decreasing marginal utility of catching fish.

Various additional, seemingly important variables which describe site characteristics were also considered. Variables such as the number of docks, fishing piers, boat ramps and boat slips

Table 5.3 Conditional Site Utility Model

$v(i\|PC,BG) =$	$\beta_1 TC_i + \beta_2 TT_i + \beta_3 \ln(M_i) + \beta_4 STH_i$	$+ \beta_6 STH_I$	$+ \beta_7 Q_{BGi}^{1/2}$	$+ \beta_9 \cdot STH \cdot Q_{BGi}^{1/2}$ $+ \beta_8 DMVNC \cdot Q_{BGi}^{1/2}$
$v(i\|PR,BG) =$	$\beta_1 TC_i + \beta_2 TT_i + \beta_3 \ln(M_i) + \beta_4 STH_i + \beta_5 B_i$		$+ \beta_7 Q_{BGi}^{1/2}$	
$v(i\|PC,SG) =$	$\beta_1 TC_i + \beta_2 TT_i + \beta_3 \ln(M_i) + \beta_4 STH_i$	$+ \beta_6 STH_I$		$+ \beta_{10} Q_{SGi}^{1/2}$
$v(i\|PR,SG) =$	$\beta_1 TC_i + \beta_2 TT_i + \beta_3 \ln(M_i) + \beta_4 STH_i + \beta_5 B_i$			$+ \beta_{10} Q_{SGi}^{1/2}$
$v(i\|SH,SG) =$	$\beta_1 TC_i + \beta_2 TT_i + \beta_3 \ln(M_i) + \beta_4 STH_i$			$+ \beta_{10} Q_{SGi}^{1/2}$
$v(i\|PC,FF) =$	$\beta_1 TC_i + \beta_2 TT_i + \beta_3 \ln(M_i) + \beta_4 STH_i$	$+ \beta_6 STH_I$		$+ \beta_{11} Q_{FF}^{1/2}$
$v(i\|PR,FF) =$	$\beta_1 TC_i + \beta_2 TT_i + \beta_3 \ln(M_i) + \beta_4 STH_i + \beta_5 B_i$			$+ \beta_{11} Q_{FF}^{1/2}$
$v(i\|SH,FF) =$	$\beta_1 TC_i + \beta_2 TT_i + \beta_3 \ln(M_i) + \beta_4 STH_i$			$+ \beta_{11} Q_{FF}^{1/2}$
$v(i\|PC,BF) =$	$\beta_1 TC_i + \beta_2 TT_i + \beta_3 \ln(M_i) + \beta_4 STH_i$	$+ \beta_6 STH_I$		$+ \beta_{12} Q_{BF}^{1/2}$
$v(i\|PR,BF) =$	$\beta_1 TC_i + \beta_2 TT_i + \beta_3 \ln(M_i) + \beta_4 STH_i + \beta_5 B_i$			$+ \beta_{12} Q_{BF}^{1/2}$
$v(i\|SH,BF) =$	$\beta_1 TC_i + \beta_2 TT_i + \beta_3 \ln(M_i) + \beta_4 STH_i$			$+ \beta_{12} Q_{BF}^{1/2}$
$v(i\|PC,NS) =$	$\beta_1 TC_i + \beta_2 TT_i + \beta_3 \ln(M_i) + \beta_4 STH_i$	$+ \beta_6 STH_I$		$+ \beta_{13} Q_{SGi}^{1/2}$
$v(i\|PR,NS) =$	$\beta_1 TC_i + \beta_2 TT_i + \beta_3 \ln(M_i) + \beta_4 STH_i + \beta_5 B_i$			$+ \beta_{13} Q_{SGi}^{1/2}$
$v(i\|SH,NS) =$	$\beta_1 TC_i + \beta_2 TT_i + \beta_3 \ln(M_i) + \beta_4 STH_i$			$+ \beta_{13} Q_{SGi}^{1/2}$

had no impact on site choice or other parameter estimates.

The travel costs are calculated at \$.20 per mile (taken from the U.S. average variable mileage costs reported by the American Automobile Association in 1988) plus the monetary opportunity cost of travel time for individuals who reported having a work schedule which they could vary as needed. The time is valued at the individual's wage rate. For persons in the interior solution category (see Bockstael, Strand, and Hanemann 1987) who did not report a wage rate, an equation predicting the wage from other variables was used.[2] For individuals with fixed working hours and no flexibility to work for wages instead of taking the trip, we include the actual travel time (TT_i) in the equation. The ln (M_i) variable is included to capture the varying degree of aggregation over different sites (Ben-Akiva and Lerman). The more sites within a county, the more likely someone is to choose that county. Including log (M_i) helps eliminate potential aggregation bias. The variable B_i is included to account for potentially different behavior to a site when individuals have boats moored at a site. Anglers are more likely to choose the sites at which their boats are moored. Appendix B describes various tests for sensitivity to travel cost, the value of travel time and other issues of estimation.

The specifications used for estimating each of the mode/species combinations are shown in Table 5.3. These specifications allow catch rates for different species to have different effects. Each 'mode' has a different model. The reaction in site choice to travel costs (given by β_1), the effect of the opportunity cost of time for non-marginal wage earners (β_2), and the effect of site aggregation (β_3) are restricted to be the same across all mode/species combinations. For the party/charter boat mode, the effect on angler's choice of southern sites not having head/party boat alternatives is captured by β_6. In the south, the NMFS field survey excluded head and party boats. Head and party boats offer an attractive outing, but with typically less personal service and less excitement than charterboats. The "experience" at a southern site will be better, all other things equal, when $\beta_6 > 0$. The private/rental boat mode site decisions include an effect (β_5) on decisions arising because anglers are more likely to choose sites where they have their boat moored. The expected signs of the coefficients are $\beta_1 < 0$, $\beta_2 < 0$, $\beta_3 > 0$, $\beta_4 > 0$, $\beta_5 > 0$, and $\beta_6 > 0$.

The remaining coefficients in the model capture the effects of expected catches on the site choice. The coefficients should reflect the contribution of the catch of various species to the angler's welfare. We would expect each of these coefficients to have a positive effect on site choice.

The parameter estimates are given in Table 5.4. These estimates come from maximum likelihood estimation. The coefficients which are important for measuring value are generally of the correct sign and significant at the 5% level. Only big gamefish catch rate was insignificant for the general case. In general, the coefficients on travel cost, travel time and $\ln(M_i)$ changed little with specification or with sample size.

The historical catch rate is a frequently used proxy for species abundance or density. As such, it is natural conduit for fisheries policy. This was its role in the production function for fish in Chapter 2. Higher historical catch rates imply higher stock density and hence greater recreational catch. Instead of using the square root of expected catch we use $\sqrt{CR_{is}}$, the historic catch rate at site i, mode species s. Utilizing historic catch rather than expected catch eliminates the production process. This model also eliminates individual heterogeneity by modelling all anglers as if they face the same catch rate, which is the historic mean catch rate. This eliminates individual effects, greatly simplifying the empirical analysis.

Table 5.4 Estimated Coefficients for the Conditional Site Choice: Expected Catch Model

Variable	Mean of Variable	Parameter	Estimate (t-ratio)
Travel cost	49.52	$\beta_1 /(1 - \sigma)$	-.036 (-22.80)
Travel time (hours)	3.28	$\beta_2 / (1 - \sigma)$	-.395 (-17.00)
Ln (M_1)	2.87	$\beta_3 / (1 - \sigma)$	.68 (37.79)
South	.38	$\beta_4 / (1 - \sigma)$	1.53 (12.49)
Boat Site	.012	$\beta_5 / (1 - \sigma)$	2.42 (14.10)
Party/charter × South	.025	$\beta_6 / (1 - \sigma)$	-.54 (-1.08)
Big Game Catch	.071	$\beta_7 / (1 - \sigma)$	-.45 (1.04)
Party/charter × South × Big Game Catch	.004	$\beta_8 / (1 - \sigma)$	8.59 (4.33)
(DE or MD or VA or NC) × Party/charter × Big Game Catch	.003	$\beta_9 / (1 - \sigma)$	4.26 (4.29)
Small Game Catch	.29	$\beta_{10} / (1 - \sigma)$	1.95 (6.96)
Flatfish Catch	.26	$\beta_{11} / (1 - \sigma)$	.961 (2.37)
Bottomfish Catch	.22	$\beta_{12} / (1 - \sigma)$	.21 (1.53)
Non-seeking Catch	.20	$\beta_{13} / (1 - \sigma)$	.46 (4.22)

Chi-squared = 9860.7, Number of observations = 46,008.

To utilize the historic catch rates means reestimating the complete model, because the scale of variables is different. The same specification is used for each of the two stages of the model. Hence the only change from Table 5.3 is that CR is substituted for Q in each of the target groups. The first stage results (Table 5.5) are similar to the previous model. The notable difference from using the historic values as the sole determinant of expectations is that the estimates for catch rate coefficients are more statistically significant, with uniformly correct signs.

5.4B Second Stage Estimates

The specification for the second stage, the choice of mode and species, is simple. It depends on the inclusive value for the mode/species choice, boat ownership, and a dummy variable for the not-seeking mode. That is, equation (5.3) can be written

$$(5.5) \qquad \text{Prob(ms)} = \frac{\exp(\gamma_1 \text{ Boat} \times D_{ms} + \gamma_2 \text{ Boat} \times D_{ms} \times \text{Cold} + (1 - \sigma)\, I_{ms})}{\sum_{j=1}^{n_{ms}} \left[\exp(\gamma_1 \text{ Boat} \times D_j + I_j(1 - \sigma)) + \gamma_2 \text{ Boat} \times D_j \times \text{Cold}\right]}$$

where I_j is the inclusive value defined previously, Boat $\times$ D_j takes a value of one if the individual owns a boat and the mode is private rental, and Cold takes a value of one for waves 2 and 6, when presumably cold weather would reduce the influence of owning a boat. The BOAT $\times$ D_j variable captures the influence of owning a boat. We would expect γ_1 to be positive, implying that boat ownership would increase the probability that an angler would choose the private/rental mode. The Cold variable would reduce this effect, so that $\gamma_2 < 0$.

The estimation results for the second stage are given in Table 5.6 for the expected catch model and for the historic catch rate model. The estimate of 1 - σ implies that $\sigma = .655$ for the expected catch model and .754 for the historic catch model. The standard errors are .013 and .015, so that these estimates are significantly different from zero and one, making the specification consistent with theory. γ_1 is positive and significantly greater than zero, and γ_2 is negative, significantly less than zero, so that both boat ownership and cold weather work according to expectations.

It is well known that simultaneous estimation of the first and second stages is more efficient than sequential estimation. However, it requires additional software. The task of moving about the datasets involved in sequential estimation is sufficiently great to discourage a

Table 5.5 Estimated Coefficients for the Conditional Site Choice: Historic Catch Rate Model

Variable	Mean of Variable	Parameter	Estimate (t-ratio)
Travel cost	49.61	$\beta_1 / (1 - \sigma)$	-.041 (-22.99)
Travel time	3.28	$\beta_2 / (1 - \sigma)$	-.45 (-17.08)
Ln (M_1)	2.87	$\beta_3 / (1 - \sigma)$	.73 (37.08)
South	.38	$\beta_4 / (1 - \sigma)$	1.75 (14.01)
Boat site	.012	$\beta_5 / (1 - \sigma)$	2.52 (12.60)
Party/Charter × South	.025	$\beta_6 / (1 - \sigma)$	1.11 (2.92)
Big Game Catch Rate	.062	$\beta_7 / (1 - \sigma)$	.38 (2.57)
Party/Charter × South × Big Game Catch Rate	.003	$\beta_8 / (1 - \sigma)$	2.11 (3.19)
(DE or MD or VA or NC) × Party/charter × Big Game Catch	.001	$\beta_9 / (1 - \sigma)$	1.45 (2.62)
Small Game Catch Rate	.46	$\beta_{10} / (1 - \sigma)$	.38 (9.03)
Bottomfish Catch Rate	.24	$\beta_{11} / (1 - \sigma)$	.15 (4.63)
Flat Fish Catch Rate	.31	$\beta_{12} / (1 - \sigma)$	.22 (4.09)
Non-targeted small game catch	.30	$\beta_{13} / (1 - \sigma)$	.12 (1.97)

Chi-squared = 9521, Number of observations = 46,008.

Table 5.6 Estimated Coefficients for the Mode/Species Choice: Expected Catch Model and Historic Catch Model

		Model Estimates	
Variable	Parameter	Expected Catch	Historic Catch
Inclusive Value	$(1 - \sigma)$	.345[a] (.013)[b]	.246 (.015)
Boat*Private/Rental Mode	γ_1	2.17 (.055)	2.14 (.055)
Boat*Private/Rental Mode*Cold	γ_2	-.693 (.103)	-.644 (.103)
χ^2		3311	2899

[a]Estimated coefficient. [b]Estimated standard error.

search for smaller standard errors at this juncture of the research.

5.5 WELFARE MEASUREMENT

One of the attractions of the RUM is its flexibility in measuring the welfare effects of various kinds of policy or exogenous events. We illustrate several kinds of welfare calculations with the RUM. Two pertinent calculations are the access values of fishing in each of the states and the welfare effects of a change in mean historic catch rates. These calculations parallel the welfare measurements of the previous chapters.

Welfare measurements are made in the standard way for a RUM model. The calculations, developed by McFadden (1973), Small and Rosen (1979), and Hanemann (1982), involve the observing economist's expected maximum value of utility. That is, the uncertainty lies with the economist, not the angler. Since individual preferences are partly random to observers, welfare measures will be random. If we calculate expected maximum utility, the randomness is eliminated. From the expected maximum utility, we can calculate compensating or equivalent variation. When the marginal utility of income is independent of income and constant across models, compensating and equivalent variation will be the same.

The individual's welfare effect of a change from situation 0 to situation 1 will be

$$W = [\log (A^0/A^1)]/\beta_1 \quad (5.6)$$

where $A^t = \sum_{j=1}^{n_{ms}} \left[\sum_{i=1}^{n_1} \exp[v_{ij}^t/(1-\sigma)] \right]^{1-\sigma}$, t = 0,1, and β_1 is the travel cost coefficient in Table 5.4. Log A^t is expected maximum utility in situation t. This is the standard RUM welfare measure. The one notable aspect of this calculation is that the choice set over which the calculation is taken is the complete choice set, not the sampled choice set. It applies to all trips for which the affected sites are relevant alternatives.

5.5A Access Values

Our first use of this welfare increase deals with valuing access to sites in each of the states in the study area. For these welfare estimates, we use the expected catch parameter of Tables 5.4 and 5.6. This is accomplished by systematically deleting specified sites from the summation for A^1 in expression 5.6. For each state, we calculate the mean of W for all individuals who were intercepted in the state. For some of our sample, such a calculation would delete all of the sites in an angler's choice set. This would imply valuing opportunity to fish, rather than the state's site characteristics, a task which our model is not equipped to handle. Those anglers who have their complete choice set eliminated are dropped from the analysis. Their elimination will tend to make the willingness to pay estimate biased downward. It happens in North Carolina once for May/June and twice for September/October and November/December. But for Florida it has considerable impact. In total 14 percent of the choice sets in the sample have only Florida sites in them. As a consequence, the willingness to pay for Florida may be considerably underestimated. The underestimation of Florida's access values is partly mitigated by the fact that good alternative sites may be found in the Florida Keys or the west coast of Florida, but the model does not reflect these alternatives. The problem for Florida is partly an artifact of the set of alternatives being eliminated. The choice of valuing access by state rather than county is arbitrary. For large states such as Florida and North Carolina, it would be reasonable to value access for subregions of the states, which could be accommodated quite easily in the model.

Table 5.7 gives the mean compensating variation for a day of fishing in each state for anglers who were intercepted in the state. Several aspects of these estimates are worth considering. First, the mean for each state depends on the distribution of trips in the sample. If this distribution does not reflect the actual, in the field distribution, the results will be biased. To assess the sample distribution, we compare it with the distribution of total trips across states,

Table 5.7 Mean Willingness to Pay for One-day Fishing Trip, by State of Destination and Wave, 1988: Expected Catch Model

	WAVE					
State	Mar/Apr	May/Jun	Jul/Aug	Sep/Oct	Nov/Dec	Annual Average
New York	$56.11	$61.43	$56.77	$60.34	$57.54	$58.52
New Jersey	44.84	32.24	34.96	33.17	33.23	33.90
Delaware	8.66	9.95	10.67	12.50	14.84	11.02
Maryland	25.54	23.68	26.43	31.12	33.95	26.59
Virginia	51.02	45.97	42.98	50.11	45.23	46.18
North Carolina	81.31	73.97	60.00	63.65	70.34	66.21
South Carolina	77.98	65.31	65.52	66.54	68.89	68.12
Georgia	43.28	46.47	42.24	37.82	39.23	41.74
Florida	85.04	83.77	84.27	79.66	74.97	80.87

as estimated by NMFS. Table 5.8 compares the distribution of total trips as estimated by NMFS with the distribution of sampling effort by the UMCP survey. The distributions are different, due to the greater intensity of sampling in the NMFS field survey and hence in the UMCP survey, by some states. Second, each estimate depends on the substitutes available. Thus, it is easy to substitute away from sites in Delaware, much harder for sites in New York or Florida.

We also computed the annual mean value of access from the model using historic catches instead of expected catches. These values are compared in Table 5.9 with the expected catch model. The values are quite similar, with the largest difference in Florida. Because these estimates are so close, we use only the expected catch model for estimates of access value.

Compared to the contingent valuation models, seasonal variation is minimal in the RUM welfare estimates. The model specification dictates this result. Two variables change over the year: the expected catch as a consequence of changes in historic catch rates, and the boat ownership, because of the cold. This impacts only a small proportion of trips, however. The values in the CV experiment depend on weather, etc. However, these factors are inherent in the number of trips taken by mode and when we expand, the aggregate welfare estimate by wave will show predictable seasonal variation.

Table 5.8 State Percent of Total: UMCP Sampling versus NMFS Total Trips

	WAVE					
State	Mar/Apr	May/Jun	Jul/Aug	Sep/Oct	Nov/Dec	State Totals
New York	10.6%[a] 15.2	11.8% 17.4	17.5% 16.5	16.0% 12.1	19.0% 7.6	15.2% 14.7
New Jersey	4.5 6.7	17.5 15.8	18.7 17.7	15.5 14.2	14.4 08.5	15.7 14.3
Delaware	9.3 0.3	5.9 3.1	5.9 4.9	8.3 2.5	4.7 0.2	0.6 3.0
Maryland	6.8 5.5	8.5 12.2	9.6 13.3	4.4 18.0	1.4 1.6	7.0 11.9
Virginia	4.5 4.5	15.7 10.4	10.2 9.3	8.9 9.7	0.3 6.1	09.6 08.8
North Carolina	06.7 11.0	11.7 12.6	13.6 11.2	17.9 14.5	18.3 10.4	13.8 12.1
South Carolina	10.3 2.1	6.4 5.0	2.8 4.0	3.9 6.2	8.2 5.4	5.4 4.7
Georgia	6.2 1.3	2.4 1.5	1.9 1.3	4.4 1.6	8.0 2.0	3.7 1.5
Florida	41.1 53.4	20.2 22.0	19.6 21.8	20.8 21.2	25.7 58.1	23.0 29.2

[a]Upper entry is the state's percent of the total sample for the UMCP survey; lower entry is state's percent of total trips for the region, estimated by NMFS.

Aggregating the estimates of willingness to pay in Table 5.7 to total willingness to pay requires careful consideration of the precise meaning of these welfare measures. They refer to a choice occasion, which in this case is a fishing trip of approximately one day. To aggregate these values, crudely, we should multiply by the number of choice occasions for which the affected sites are relevant alternatives. That is, people in Florida will not be affected by closing New York sites. We aggregate by multiplying by the number of trips taken in the state. This is an underestimate of the number of choice occasions which are relevant for each state because individuals taking trips to other states might have our eliminated sites in their choice set.

Table 5.9 Annual Means of Value of Access by State: Expected Catch Rate and Historic Catch Rate

State	Expected Catch Model Tables 5.4 and 5.6[a]	Historic Catch Models Tables 5.5 and 5.6
New York	$58.32	$57.35
New Jersey	33.90	32.16
Delaware	11.02	10.16
Maryland	26.59	27.22
Virginia	46.18	38.10
North Carolina	66.21	68.34
South Carolina	68.12	67.28
Georgia	41.74	39.32
Florida	80.37	67.28

[a]These figures are also in the last column of Table 5.7.

The NMFS estimates of fishing trips by wave and state are given in Table 5.10. They are multiplied times the mean value of access per choice occasion, given Table 5.7. Results for total willingness to pay are given in Table 5.11. These are in millions of dollars. They range from $.1 million for March/April in Delaware to a maximum of over $225 million for July/August in Florida.

The values in Table 5.11 must be considered independently of one another. The temptation is to sum them and obtain a value of over a billion dollars. However, they are each determined as if the fishing experience is lost in that one state and one wave only. Each state's access values are dependent on the remaining opportunities available in other states. The access value of Delaware is small because anglers can go to New Jersey or Maryland. Without New Jersey or Maryland, its access value would be much higher. The sum of the access values is a gross underestimate of the loss of access to marine recreational fishing in the whole area.

Values based on the elimination of state sites are inherently related to size of the state involved. The ability of an angler to substitute away from a set of eliminated sites depends on the distances involved. To give a sense of this effect, we have computed mean willingness to pay for access to two combinations of states, North Carolina/Virginia and Maryland/Delaware

Table 5.10 Total Fishing Trips, by Wave and State, 1988 (thousands)

	WAVE					
State	Mar/Apr	May/Jun	Jul/Aug	Sep/Oct	Nov/Dec	Total
New York	616	1,557	2,058	954	317	5,502
New Jersey	273	1,410	2,207	1,122	357	5,369
Delaware	13	276	616	199	10	1,114
Maryland	222	1,091	1,656	1,424	65	4,458
Virginia	183	933	1,161	769	257	4,280
North Carolina	444	1,123	1,389	1,148	437	4,541
South Carolina	85	446	495	492	228	1,746
Georgia	53	135	164	125	82	559
Florida (East Coast)	2,165	1,996	2,711	1,674	2,435	10,981
Total	4,054	8,937	12,457	7,907	4,188	

Source: Unpublished data, National Marine Fisheries Service, Silver Spring, Md.

Table 5.11 The Value of Access: Total Willingness to Pay, by State of Destination and Wave, 1988[a]

	WILLINGNESS TO PAY (millions $)					
State	Mar/Apr	May/Jun	Jul/Aug	Sep/Oct	Nov/Dec	Total
New York	34.6	95.6	116.8	57.6	18.2	322.0
New Jersey	12.2	45.5	77.2	37.2	11.9	182.0
Delaware	0.1	2.7	6.6	2.5	0.1	12.3
Maryland	5.7	25.8	43.8	44.3	2.2	118.5
Virginia	9.3	42.9	49.9	38.5	11.6	197.6
North Carolina	36.1	83.1	83.3	73.1	30.7	300.7
South Carolina	6.6	29.1	32.4	32.7	15.7	118.9
Georgia	2.3	6.3	6.9	4.7	3.2	23.3
Florida (East Coast)	184.1	167.2	228.5	133.3	182.6	888.0

[a]Each entry is the product of the appropriate state-wave cells from Table 5.10 and Table 5.7.

(Table 5.12). While the average loss to anglers intercepted in North Carolina from eliminating North Carolina sites is around \$65/trip and to anglers intercepted in Virginia from eliminating Virginia sites is around \$45/trip (Table 5.7), the average of anglers intercepted in North Carolina or Virginia from eliminating access to sites in both states is around \$120/trip (Table 5.12). Similarly, the individual values for Delaware and Maryland average from \$10 to \$25, but the elimination of sites in Delaware and Maryland raises the average to the \$40 range (Table 5.12). The aggregation effect is smaller for Delaware and Maryland because there are still many fishing alternatives for these anglers even if Maryland and Delaware are both eliminated.

Table 5.12 Willingness to Pay for Access to Combinations of States

Wave	Mean[a] Willingness to Pay for Access to Sites in:					
	Delaware only[b]	Maryland only[b]	Delaware and Maryland	North Carolina[b]	Virginia[b]	North Carolina and Virginia
Mar/Apr	\$8.66	\$25.54	\$42.48	\$83.31	\$51.02	\$152.42
May/Jun	9.95	23.68	37.27	73.97	45.97	138.94
Jul/Aug	10.67	26.43	38.87	60.00	42.98	125.11
Sep/Oct	12.50	31.12	42.64	63.65	50.11	134.61
Nov/Dec	14.84	33.95	39.85	70.34	45.23	105.95

[a]Represents mean for those individuals who had some alternative marine recreational angling sites available after the selected sites were eliminated.
[b]From Table 5.7.

5.5B The Value of Enhanced or Lost Catch

The gains or losses to anglers from changing fish availability can be calculated using the RUM and the expected catch models of Chapter 2. The welfare measure for an individual is

(5.7)

$$W = \ln\left[\sum_{j=1}^{n_{mg}}\left[\sum_{i=1}^{n_i} \exp\left(v_{ij}^{0}/(1-\sigma)\right)\right]^{1-\sigma}\right] - \ln\left[\sum_{j=1}^{n_{mg}}\left[\sum_{i=1}^{n_i} \exp\left(v_{ij}^{1}/(1-\sigma)\right)\right]^{1-\sigma}\right]$$

where the v_{ij} are given by

$$v_{ij} = v(i|j) + \gamma_1 \text{ Boat} + \gamma_2 \text{ Boat} \times \text{Cold}$$

where Boat = 1 if the mode is private rental and the person owns a boat

Cold = 1 for waves 2 and 6

$v(i|j)$ = conditional site utilities given in Table 5.3.

The parameters for $v(i|j)$ are in Table 5.4; the $1 - \sigma$, γ_1, and γ_2 are in Table 5.6.

The conditional site utilities depend on expected catch. When expected catch changes, welfare changes through the expression for W above. The Poisson models described in Chapter 2 provide a mechanism for filtering objective changes through individual characteristics to heterogenous responses, especially to fish stocks. The basic structure of expected catch with the Poisson model is

(5.8) $$Q_{is} = A_{is} \exp(\beta_s CR_s)$$

where A_{is} is an individual-specific constant which varies by species group, β_s is a species-specific coefficient and CR_s is the historic catch rate for the species group. This equation comes from the estimated equations from Chapter 2, which can be written

(5.9) $$Q_{is} = \exp[\alpha_s x_i + \beta_s CR_s]$$

where $A_{is} = \exp(\alpha_s x_i)$. (See equation 2.2, Chapter 2.) The square root of Q_{is} then becomes an argument of the utility function according to Table 5.3.

Table 5.13 shows the average willingness to pay per angler if historic catch rates (CR in equation 5.8) for all sites, waves and modes are increased by .5 fish per trip. That is, $Q^1_{is} = A_{is} \exp(\beta_s(CR_s + .5))$. In effect, this is an increment in resource stock which goes across all species, and works through the production function estimated in Chapter 2. The last column gives the aggregate value of improved catch, calculated as the product of NMFS estimate of total trips (Table 5.9) and our mean willingness to pay (Column 2). These numbers are small. One reason for this is that catch rates for all species, including the marginally desirable ones, are changed. The coefficients in Table 5.4 relate to the marginal utility of a species "aggregate," where the mean is taken over all species in the group, not just the most desirable. For example, bottomfish includes spot and croaker as well as snapper and grouper. Also, because the more commonly available fish (i.e., spot and croaker) dominate the historic harvest data, they will have a larger effect on the estimated coefficient. Both effects tend to reduce the impact of increased

Table 5.13 Welfare Effects of an Increase in Mean Historic Catch Rates of .5 Fish/Trip: Expected Catch Model[a]

WAVE	$'s PER OCCASION MEAN	AGGREGATE ($1,000's)[b]
MAR/APR	$.33	$1,337
MAY/JUNE	.25	2,234
JUL/AUG	.22	2,740
SEP/OCT	.23	1,819
NOV/DEC	.33	1,382

[a]The change in expected catch is determined by $Q^1_{is} = A_{is}\ \exp\ (\beta_s(CR^0_s + .5))$.
[b]The product of the first column and aggregate trips per wave, the bottom row of Table 5.10.

historic catch rates.

There is an additional reason why the increments to historic catch result in small welfare gains. The estimated Poisson production process yields much less than a .5 increment to expected catch. That is, the net increase in Q from a change in CR equal to .5 is given by $Q^\circ(e^{.5\beta s} - 1)$, where Q° is the current value. (That is, $Q^1 - Q^\circ = Q^\circ(e^{.5\beta s} - 1)$.) This will be quite a small number for some of the equations in Chapter 2.

To demonstrate how the historic catch rate is damped by the production function, we calculate welfare measures for a change in expected catch. Each expected catch is increased by one-half (.5) fish per trip:

$$Q^1_{is} = Q^0_{is} + .5 \qquad (5.10)$$

instead of $Q^1 = A_{is}\ \exp\ (\beta_s(CR_s + .5)) = Q^0_{is}\ \exp(.5\beta s)$. This change in expected catch is equivalent to making all anglers equally more successful, rather than the previous analysis, which increased the opportunities equally for all anglers. These welfare effects are given in Table 5.14. They are on the order of 30 times as high, because the Poisson process, as we have estimated it, dampens the effect of changes in the historic catch rate.

We also employed the model that used historic catches directly (Tables 5.5 and 5.6), not expected catches to estimate an increase of .5 fish per trip. The values (shown in Table 5.15) are many times greater than the ones computed from the expected catch model. Using this model, the aggregate value of increasing all mean historic catches by .5 fish per trip ranges from over $15 million in March/April to over $40 million in July/August. For the year, the total gains are about $145 million or about 15 times greater than the $9.4 million generated with the expected catch model in Table 5.13.

Table 5.14 Welfare Effects of an Increase in Expected Catch of .5 Fish/Trip[a]

WAVE	$'s PER OCCASION MEAN	AGGREGATE ($1,000's)[b]
MAR/APR	$8.11	$32,878
MAY/JUNE	8.12	72,568
JUL/AUG	7.52	93,677
SEP/OCT	7.51	59,382
NOV/DEC	8.13	34,048

[a]The change in expected catch: $Q^1_{is} = Q^0_{is} + .5$; coefficients from Tables 5.4 and 5.6.
[b]The product of the first column and aggregate trips per wave, the bottom row of Table 5.10.

The RUM is quite flexible in its ability to estimate gains and losses to anglers imposed by government policies towards fisheries. Suppose, for example, that the Mid- and South Atlantic Regional Councils agreed to prohibit for one year the harvest of summer flounder. To

Table 5.15 Welfare Effects of an Increase in Mean Historic Catch Rates of .5 Fish/Trip: Historical Catch Model[a]

WAVE	$'s PER OCCASION MEAN	AGGREGATE ($1,000's)[b]
MAR/APR	$4.28	$17,351
MAY/JUNE	3.98	35,569
JUL/AUG	3.71	46,215
SEP/OCT	3.55	28,070
NOV/DEC	4.34	18,176

[a]$CR^1 = CR^0 + .5$; coefficients from Tables 5.5 and 5.6.
[b]The product of Column 1 and aggregate trips per wave, the last row of Table 5.10.

calculate the welfare effect of eliminating summer flounder, we exploit equation 5.7 where the v_{ij} are calculated at new expected catches, when the expected catch restricts the catch of summer flounder to zero. In our model, this would translate to the elimination of catch of summer flounder catch, which represents approximately 2/3 of historic East Coast target "flatfish" catch. We can assess the effect by determining, within our sample, the proportion of summer flounder in the total flatfish category. The new expected catch is

$$Q_{is}^{1} = Q_{is} \cdot (1 - \delta_{ff}) + Q_{is} \cdot \delta_{ff} \cdot (1 - p_{sf}) \qquad (5.11)$$

where Q_{is} is the current catch, δ_{ff} is one when the species group is flatfish and p_{sf} is the wave-state specific proportion of summer flounder in the flatfish group. For the non-flatfishing groups ($\delta_{ff} = 0$), there is no change in catch rates. If p_{sf} is zero, there is no change in catch rates. We then reduce the historic catch rates by that proportion and compare the welfare effects of this to the base value.

Table 5.16 shows for each state/wave combination the angler losses (willingness to pay to avoid the policy) from a summer flounder moratorium. These numbers show the losses in each state as a consequence of the complete moratorium on summer flounder. Hence, in November/December, summer flounder fishing is reported only in North Carolina, but the lost opportunities reduces the value of trip occasions in Virginia and South Carolina also due to the nature of the opportunity set. Not surprisingly, the largest two-month losses occur in New Jersey and New York during July and August. This occurs because summer flounder is a highly targeted species there during the summer.

5.6 THE DEMAND FOR TRIPS

In our analysis thus far, we have assumed that the value per trip changes but the number of trips remains constant. This of course would not happen. The RUM with trips constant is an approximation. In fact, anglers will adjust their trips if the changes in circumstances are significant. To assess the response of trips, we estimate our model of the demand for aggregate trips. As in Bockstael, Hanemann and Kling, we take the practical approach of estimating trips as a function of the inclusive value, and other variables. The general two month demand for trips is

$$T = f(\text{income, wave, IV})$$

where IV is defined below and T is the number of trips reported in the wave.

Table 5.16 Willingness to Pay to Avoid an East Coast Summer Flounder Moratorium, by Wave and State[a]

State	Mar/Apr	May/Jun	Jul/Aug	Sep/Oct	Nov/Dec
	---------- in $thousands ----------				
New York	0	1,137	3,910	1,526	0
New Jersey	8	2,270	5,716	1,818	0
Delaware	14	516	1,349	308	0
Maryland	302	2,848	2,948	1,524	
Virginia	375	975	1,765	1,638	51
North Carolina	108	1,100	1,486	1,378	332
South Carolina	0	53	38	54	20
Georgia	0	0	0	3	0
Florida	0	0	0	857	0

[a]Per trip losses × number of trips taken in the state during the wave, from Table 5.10.

The dependent variable is a count variable, and for many households it is a small integer. Hence we assume that trips are distributed as a Poisson process, so that

$$\text{Prob}(\text{trips} = T) = \frac{e^{-\lambda}\lambda^{T}}{T!}.$$

The conditional mean of T is specified as:

$$\lambda = \exp\left[\mu_1 \, IV + \mu_2 \, IV \, \mathbf{REGION} + \beta \, \mathbf{w} + \delta \, \mathbf{y}\right]$$

where μ_2, β and δ are vectors of parameters. The variables are formed using:

IV: The inclusive value — expected maximum utility (Log A^0 in equation 5.6).

w_2-w_6: dummy variables indicating waves two through six.

y_1 - y_7, y_{NEC}: dummy variables for income categories:

y_1 income < $15,000

y_2 income $15,000 to $29,999

y_3 income \$30,000 to \$44,999

y_4 income \$45,000 to \$59,999

y_5 income \$60,000 to \$74,999

y_6 income \$75,000 to \$89,999

y_7 income > \$90,000

y_{NEC} not elsewhere classified, refused, don't know

μ_1 = coefficient on inclusive value

$\mu_2 \cdot REGION \cdot IV$

$$= (\mu_{21} \cdot IV \cdot DMV) + (\mu_{22} \cdot IV \cdot NC) + (\mu_{23} \cdot IV \cdot SCGA) + (\mu_{24} \cdot IV \cdot FLA)$$

and DMV = 1 if state of intercept was Delaware, Maryland or Virginia

NC = 1 if state of intercept was North Carolina;

SCGA = 1 if state of intercept was South Carolina or Georgia;

FLA = 1 if state of intercept was Florida.

The IV variable provides the connection to the nested logit model. If sites are closed, catch rates change or costs go up, then IV will change, and anglers will adjust their trips. IV is calculated in equation 5.6, where log (A) = IV. Some change in circumstances will change IV, and the new inclusive value will be A^1. Computationally, the program which generates the welfare effects per trip also generates the variables used to predict the change in the number of trips. The IV variables are interacted with the regional indicator variables to allow the effects to differ by region. Estimates from a truncated Poisson estimation are shown in Table 5.17.

The wave dummies show a pattern of otherwise unexplained demand which increases over wave six (November-December) for each two month period. The income variable is systematically negative. Each increase in income over \$15,000 brings a bigger decline in the expected number of trips. The coefficients on variables such as IV · NC are estimates for the difference between New York/New Jersey and the state associated with the dummy variable. All of the regions are statistically different from (less than) New York/New Jersey. Finally, the basic IV variable is positive and significantly different from zero. This means that factors which increase utility to the angler, such as catch rates, also increase trips, while utility-reducing factors reduce trips.

Table 5.17 A Truncated Poisson Model of the Demand for Trips

Variable	Coefficient	t-ratio*
Constant	-.249	4.38
IV	.371	32.20
IVDMV	-.031	6.09
IVNC	-.025	3.37
IVSCGA	-.030	4.25
IVFLA	-.023	4.82
w_2	.191	5.26
w_3	.291	10.13
w_4	.288	10.76
w_5	.111	3.92
y_2	-.174	5.08
y_3	-.192	5.64
y_4	-.282	7.84
y_5	-.274	6.13
y_6	-.435	7.56
y_7	-.390	7.49
y_{NEC}	-.381	9.83
Number of Observations =	5156	
Chi-squared =	22,929	

*Null hypothesis of no association.

The estimated equation can be used to predict the lost trips as a consequence of a site-specific exogenous event. The exogenous event works through the inclusive value. As an example, let us consider impact of a .5 change in the historic catch, through the production process. With trips held constant, these results are in Table 5.13. As discussed above, this can be thought of as an increase in stock density, since it works through individual production functions. The conditional mean of trips per person for the Poisson is given by the expression

$$ET^0 = \exp(\alpha \mathbf{x} + \mu_1 IV^0 + \boldsymbol{\mu}_2 \cdot \mathbf{REGION} \cdot IV^0)$$

where IV^0 denotes the initial situation and αx is the inner production of coefficients and variables for all other influences. When catch rates change, the inclusive value increases, causing trips to increase. Hence the new value of trips becomes

$$ET^1 = \exp(\alpha \mathbf{x} + \mu_1 IV^1 + \boldsymbol{\mu}_2 \cdot \mathbf{REGION} \cdot IV^1)$$
$$= E^0 \cdot \exp(\mu_1(IV^1 - IV^0) + \boldsymbol{\mu}_2 \cdot \mathbf{REGION} \cdot (IV^1 - IV^0))$$

Table 5.14 shows the per trip and aggregate effects of the increment in catch rates, assuming trips are constant. These are calculated as means per trip. The aggregate is simply mean aggregate number of trips. Assessing impacts via the trip demand function requires aggregating over anglers, not over days. Nevertheless, having the trip demand function lets us assess the impact of the constant trip assumption.

Here are the three possible welfare measures per angler

(5.9) constant trips:

$$T^0 \cdot W$$

(5.10) Morey's approximation (Morey, 1994)

$$.5 \cdot (T^0 + T^1) \cdot W$$

(5.11) Bockstael, Hanemann, and Kling's estimate (Parsons and Kealy, 1994, equation (9)):

$$(T^1 \cdot IV^1 - T^0 \cdot IV^0)/\beta_1,$$

where β_1 is the estimated marginal utility of income. For calculation, T^1 and T^0 are trips estimated with the new and original catch rates. Note that equations 5.9, 5.10, and 5.11 are equal if $T^1 = T^0$, but that they are not equal if T changes. For constant $T^0 = T^1$ equation 5.10 and 5.11 are equal because

$$W = \frac{IV^1 - IV^0}{\beta_1}$$

from equation 5.6.

For comparison, annual means are provided. These are means per two month wave, taken over all waves:

(5.9′) $T^0 \cdot W = \$.95$

(5.10′) $.5 \cdot (T^0 + T^1) \cdot W = \$.96$

(5.11′) $(T^1 IV^1 - T^0 IV^0)/\beta_1 = \$2.32$

These means are taken over the 5156 observations on anglers who took single day trips. The calculation in (5.10′) demonstrates that the adjustment in trips is really quite small, which of course makes sense from the relatively low welfare measures in Table 5.13. Welfare measures are low, implying a small change in IV, and hence a small change in trips. But the measure in (5.11′) is considerably higher. This occurs because of high correlation between IV and T, as would be expected from the estimated equation, which has T as an increasing function of IV.

The sensitivity of total value estimates to the consideration of trip response effects is demonstrated in Table 5.18. Consider New York, the first row in the table. In March and April, the estimated value ($148,000) is calculated using no trip response to changes in catch rate. The second sub-row shows the value ($335,000) computed using the average of observed and expected trips. This is simply a value per trip times the number of trips. The final sub-row in New York shows the dramatic effect of using the Bockstael et al. method along with the estimates of participants. This method produces estimates that are universally greater than the other two methods and frequently greater than five times the value of sub-row 1.

The second and third rows are values per participant, and are multiplied by the number of participants. Since NMFS participation is by state, and a person can participate in more than one state, the second and third rows involve counting some people more than once. As opposed to aggregates computed from average value/trip (sub-row 1), they are usually higher. This arises because the average value/angler is expanded based on the NMFS estimate of participants per state. Because estimates of aggregate trips and participants have different error components, the value in the first two rows vary substantially. The largest variation occurs in the summertime, when the aggregate value computed from participants averages about 50% more.

The point of this illustration is to reveal the conservative nature of the aggregate values presented in Table 5.11, 5.13, 5.14 and 5.15. That is, the values/trip for enhanced stocks produced by the RUM do not consider that some consumers will increase their fishing trips. When this is introduced, as in Table 5.18, the estimated values increase dramatically in some cases.

Unfortunately, it is not an easy task to remove variation introduced by going from an aggregate value calculated using aggregate trip estimates to one generated using aggregate participant estimates. Because Table 5.18 reveals the potential for large error from this switch, we choose to present the traditional RUM values, even with their conservative nature.

Table 5.18 Aggregate Value of an Increase in Historic Catch of .5 Fish/Trip for the Expected Catch Model, By Method, Wave and State

STATE	WAVE				
	MAR/APR	MAY/JUN	JUL/AUG	SEP/OCT	NOV/DEC
	----- In $1,000's -----				
New York	148[a] 335[b] 871[c]	303 482 1,277	321 350 895	182 156 402	95 50 127
New Jersey	31 131 321	270 440 1,100	465 382 1,164	191 163 412	115 81 199
Delaware	43 7 16	46 78 195	117 129 314	37 32 81	20 1 3
Maryland	52 119 294	188 265 647	318 422 1,031	268 277 682	12 7 17
Virginia	37 74 192	232 395 965	278 366 948	183 145 383	64 50 123
North Carolina	131 273 643	319 580 1,429	382 666 1,685	302 391 994	128 102 241
South Carolina	30 79 206	150 346 888	183 372 984	175 375 1,005	85 113 282
Georgia	20 39 104	47 101 282	72 110 293	49 64 174	37 37 93
Florida	849 1,173 3,091	731 1,035 2,842	975 1,477 4,040	558 653 1,824	869 825 2,159

[a]First row: W × aggregate trips (expression 5.9′).
[b]Second row: Participants × $W(T^1 + T^0).5$ (equation 5.10′).
[c]Third row: Participants × $(T^1IV^1 - T^0IV^0) / \beta_1$ (equation 5.11′).

W taken from column 2, Table 5.13. T^1 and T^0 are based on UMCP sample. Participants from NMFS unpublished statistics. Aggregate trips in Table 5.10.

The model of the demand for trips makes the RUM more consistent with the theory of choice. As can be seen from the analysis of changes in catch rates, ignoring the change in trips underestimates the correct welfare measure. However, incorporating the trip demand is not without problems. It converts the unit of analysis from a per trip occasion to an individual. While this is quite consistent with economics, it is not necessarily easy to make operational, because NMFS and other statistics in the aggregate are more reliable for trips than participants.

5.7 CONCLUSION

This chapter has reported on the estimation and use of a RUM over the study region. This model gives robust estimates of the value of access. It can be used in a variety of other ways, as we demonstrated. For example, the model can estimate the welfare effects of a moratorium on summer flounder. It can be used to model the welfare effects of various changes in catch rates. We have also estimated a trip demand model which is a function of the outcome of the RUM choice. This part of the model can be used to adjust trips when circumstances change.

In addition to the analysis reported in this chapter, we have conducted several sensitivity analyses of the model. As suggested by a previous review of this study, we included measures of site facilities, including fishing piers, boat ramps, boat slips, and docks. Various forms of these measures of public facilities were not significant in the model. We also estimated a variation on the basic model by taking the log of expected catch, rather than the square root, which had no impact. While there are many additional specifications one could test for robustness, there is no evidence that these changes have any impact on the value of access. Some sensitivity results are reported in more detail in Appendix B.

ENDNOTES

1. One approach to handling this sportfishing multiple choice problem in the context of the discrete choice model is to treat it as one estimation problem by including all possible site/mode/target species combinations in the alternative set. In this case the individual would choose among these site/model/species combinations based on the indirect utility function

$$v_{ims} = v_{ims}(z_{ims}) + \varepsilon_{ims}$$

where v_{ims} is the indirect utility associated with choosing site i, mode m, and target species s. The vector z_{ims} includes variables which affect utility and which could vary with any or all of the three dimensions of the alternatives. The term ε_{ims} is a random term assumed known to the participant but unknown to the researcher. If the random term is distributed as a Weibull, this model can be estimated using a simple multinomial logit (McFadden 1973).

2. For people whose wage is not reported, we predict it by estimating the following equation:

$$\ln W = \alpha_1 + \sum_{i=2}^{9} \alpha_i y_i + \alpha_{10} \text{ age} + \alpha_{11} \text{ gender} + \text{error}$$

where

y_i = 1 if the respondent's income is in income level i, 0 otherwise
gender = 1 if respondent is male
age = age in years.

The income categories are:

y_2: $15,000 \leq y < 30,000$
y_3: $30,000 \leq y < 45,000$
y_4: $45,000 \leq y < 60,000$
y_5: $60,000 \leq y < 75,000$
y_6: $75,000 \leq y < 90,000$
y_7: $\geq 90,000$
y_8: don't know
y_9: refused to answer

The estimated model is

VARIABLE	PARAMETER ESTIMATE	STANDARD ERROR	T-STATISTIC
CONSTANT	1.48313288	0.05688587	26.072
y2	0.21402506	0.03839345	5.575
y3	0.48484363	0.03901371	12.428
y4	0.56690330	0.04206187	13.478
y5	0.74011877	0.06546715	11.305
y6	0.56711715	0.09186481	6.173
y7	0.66561170	0.09985817	6.666
y8	0.10287094	0.05914235	1.739
y9	0.20241332	0.07215818	2.805
gender	0.36231234	0.03846928	9.418
age	0.005950329	0.000857565	6.939

$\bar{R}$ = .296; n = 1442.

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Chapter 6
CONCLUDING NUMBERS AND THOUGHTS

6.1 INTRODUCTION

In the previous five chapters we have presented a great many numbers pertaining to the economic value of marine recreational fishing on the East Cost of the U.S. We have shown estimated values by state which range from less than $1 million for fishing trips which are taken as a component of overnight trips in Georgia to over $1 billion for the annual value for all marine fishing in Florida on the East Coast. These estimates add perspective to policy debates over programs such as those that would reduce water pollution or improve fisheries management. In this chapter, we expand on the specific numerical estimates by computing asset values of access, comparing the contingent values with behavior-implied values and discussing these findings.

6.2 ASSET VALUES OF ACCESS TO MID- AND SOUTH ATLANTIC MARINE SITES

Our first observation is that the marine resources of the Mid- and South Atlantic which support recreational fishing are worth a lot. Benefit measures with willingness to sell, as with any method, are not perfect and perhaps overstate the access values.[1] But it is nevertheless clear that the estimated asset value of these marine resources is enormous.[2] These asset values are equivalent to other asset values, such as the value of farms or stocks and bonds, which yield continuing services over time. For example, let us assume that the correct figure for the annual value of access is represented by the last column of Table 3.4. Then eliminating forever all marine recreational fishing in all states, assuming a 5% discount rate, would create the asset values shown in Table 6.1. The total asset value is about $100 billion (the sum of column 2 in Table 6.1). This is the value of the losses that would be suffered if marine recreational fishing in all nine states were eliminated forever. This estimate is based on the contingent valuation question which asks the value of access for the East Coast.

It is perhaps more pertinent to discuss the present value or asset value of marine recreational fishing by state. Again, as in Table 3.4, Florida ranks highest among the states with nearly $10 billion greater value than North Carolina, the next highest. Delaware and Georgia have the lowest asset value among the states.

Table 6.1 Asset Value of Marine Recreational Fishing, By State, 1988[a]

ASSET VALUE FOR ANGLERS FROM:	ASSET VALUE[b] ($billion)
New York	7.2
New Jersey	13.2
Delaware	2.7
Maryland	13.0
Virginia	8.4
North Carolina	18.1
South Carolina	8.0
Georgia	1.8
Florida	26.7

[a]Source: Table 3.4, Column 2. The values here are for the whole East Coast study area, while the state figure is for the number of anglers in that state.

[b]At 5% real rate of interest.

The asset value of Table 6.1 is based on a variety of assumptions. Recall that the total value per period of time is the product of the number of anglers and its value per angler. Systematic changes in these variables will result in systematic changes in the asset value. Some potentially important changes are:

1. Population growth. If the coastal population grows, the number of anglers will also grow. This will increase the asset value. This increase in asset value would be attentuated if congestion or lower fish densities were a consequence of more anglers.

2. Changes in the quantity and distribution of pollution. Two kinds of changes can occur. If fresh water resources become more polluted, the marine environment will be more attractive, increasing the value of access for anglers and the asset value. However, if legislation such as the Clean Water Act and its revision improves fresh water relative to salt water, then the value of the asset will decline.

3. Changes in tastes and other factors affecting the value of salt water angling. While salt water angling is not subject to volatile changes in tastes in the short run, long-run changes in which anglers value saltwater fishing more highly will also increase the asset value.

Another observation is that the value of marine and other natural resources in a state does not depend solely on how much they are preserved or polluted. The least developed coastal area on the East Coast is Georgia, but the aggregate value of recreational fishing in Georgia is low because few people fish there. The low level of fishing activity is due to small coastal populations, short coastline and relatively fewer resources devoted to marine access. It takes marine infrastructure, as well as the natural capital of fish stocks, to provide recreational fishing services.

6.3 A COMPARISON OF SALTWATER FISHING ACCESS VALUE

Our second observation is that the estimated value of access computed by our behavioral model is not dramatically different from the estimated values computed using the contingent valuation method. Table 6.2 presents the estimated CVM and RUM aggregate values for each wave/state combination. For certain of the smaller states (e.g. Delaware, Maryland and Georgia) the values diverge substantially, but not by an order of magnitude. The values for the larger states (e.g. New York and Florida) are quite close.

One explanation for the divergence in the small state values is the possibility that the CVM respondents do not consider out-of-state alternatives when asked about the bid to stop fishing. While this may be an artifact of the survey, it may also be a true indication of the lack of substitutability. The RUM model considers individuals to be knowledgeable about alternative sites. If they are not and their lack of knowledge is correlated with travel costs, then the travel cost model may be overstating the effect of costs on choices, leading to an underestimate of the access value. Both suggest more research into the values presented in Table 6.2.

6.4 COMPARISON OF VALUES OF INCREASE EXPECTED CATCH

Both the RUM and the CV methods have been used to value improvements in catch. This aspect of sportfishing is an important focus of policy, and it is worthwhile to compare the results of the two valuation methods.

Table 6.2 Aggregate Value of Access to State Saltwater Fishing, By Wave, 1988-1989

REGION		WAVE ($, millions) MAR/APR	MAY/JUN	JUL/AUG	SEP/OCT	NOV/DEC	JAN/FEB
MID-ATLANTIC							
New York	CVM[a]	--	178	152	42	4	--
	RUM[b]	35	96	116	58	18	--
New Jersey	CVM	--	92	198	50	8	--
	RUM	12	46	77	37	12	--
Delaware	CVM	--	17	47	8	0	--
	RUM	0	3	7	3	0	--
CHESAPEAKE							
Maryland	CVM	--	95	167	73	1	--
	RUM	6	26	44	44	2	--
Virginia	CVM	--	133	91	29	10	--
	RUM	9	43	50	39	12	--
SOUTH ATLANTIC							
North Carolina	CVM	--	123	164	93	18	1
	RUM	36	83	83	73	31	--
South Carolina	CVM	--	68	56	70	16	--
	RUM	7	29	32	33	16	--
Georgia	CVM	--	23	13	9	5	--
	RUM	2	6	7	5	3	--
Florida (East Coast)	CVM	--	180	272	130	128	193
	RUM	184	167	229	133	183	--

[a]Compiled from Table 3.4.
[b]Compiled from Table 5.11.

Table 6.3 compares the mean value per trip of additional fish stocks obtained in the RUM and CVM analyses. The CVM analysis provided values for increased expected catch rate by angler (Table 3.9) and these values were converted to a per-trip basis by dividing the values by the number of trips each angler took. They were then averaged over all anglers for each wave. The RUM values were taken directly from Table 5.14.

The values shown in Table 6.3 are for the "representative" increase in expected catch of all species by one-half fish. That is, they show for the "average" trip, how much the angler would value an increase of one-half additional fish in their expected catch. This value takes into consideration what species the anglers were targeting. The values shown in the table are surprising close. The high values shown in January probably reflect a relatively greater preponderance of anglers seeking big gamefish and the higher value placed on these fish. The results are encouraging regarding our use of the "expected" catch approach.

Table 6.3 Comparison of the Value of Sportfish, by Method of Analysis

	Value ($) Per Angler for Improved Expected Catch of One-half Fish Per Trip for a Two-Month Period	
WAVE	RUM ESTIMATE[a]	CVM ESTIMATE[b]
JAN/FEB	NA	$16.78
MAR/APR	$8.11	NA
MAY/JUN	8.12	8.89
JUL/AUG	7.52	8.86
SEP/OCT	7.51	8.53
NOV/DEC	8.13	7.08

[a]Based on values shown in Table 5.14.
[b]Computed by taking the difference between base CV and CV with base expected catch rate plus one-half fish and dividing by the trips per angler in the two-month period. This value was then averaged across species groups for each wave.

But we should caution that the values probably underestimate the improvement of fish stocks. There are several reasons for the underestimation. Perhaps most important, these values are attributed only to anglers who were fishing and who were seeking the species group in question. A significant improvement in fish catch might increase the numbers of anglers as well as the number in the mode/species group of anglers. Our estimates are based on a constant number of individuals seeking a species group and a constant number of total anglers, dampening the estimated potential benefits of improved fishing. In addition, it is possible that the actual estimate of the response to catch is biased downward.

6.5 A CONCLUDING THOUGHT

Even though sportfishing resources are worth a lot, that by itself is not enough to justify all marine fisheries policies. Preserving or enhancing fishing opportunities imposes other kinds of costs on society. If the fishing is enhanced by a reduction in pollution, efficient resource allocation will dictate that we compare the benefits of improved fishing with the costs of pollution control. If we improve recreational fishing by imposing restrictions on the commercial fishing sector, the recreational benefits must be weighed against the losses of consumer surplus to the consumers of fish and of profits to harvesters and processors of fish.

ENDNOTES

1. The contingent valuation of Chapter 3, based on willingness to sell questions, is a necessary compromise with anglers' attitudes towards fishery policy. It is recognized that willingness to sell questions can create upward biases in values (Mitchell and Carson, 1989). Initial experiments and pilot studies using willingness to pay questions produced frequent refusals. This stems in part from opposition to sportfishing licenses, which have been a contentious political issue for at least a decade.

2. The asset value of a resource is the present discounted value of the stream of all generated values indefinitely into the future.

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Appendix A: Site Definitions

NEW YORK SITES

1. Kings
2. *Nassau (Long Island Sound side)
3. *Nassau (Ocean side)
4. Richmond
5. Suffolk (Long Island Sound side)
6. *Suffolk (Peconic and Gardiners Bay)
7. *Suffolk (Ocean side)
8. Westchester

NEW JERSEY SITES

9. Atlantic
10. Bergen
11. *Cape May (Delaware Bay side)
12. *Cape May (Ocean side)
13. Cumberland
14. Hudson
15. Middlesex
16. *Monmouth (South of Sandy Hook)
17. *Monmouth (Sandy Hook north)
18. Ocean
19. Salem

DELAWARE SITES

20. Kent
21. New Castle
22. *Sussex (South of Lewes)
23. *Sussex (Lewes north)

MARYLAND SITES

24. Anne Arundel
25. Baltimore/Harford
26. Calvert
27. Caroline/Kent/Queen Annes/Talbot
28. Cecil
29. Charles/St. Marys
30. Dorchester/Somerset/Wicomico
31. Worcester

VIRGINIA SITES

32. Accomack/Northampton
33. Essex/Gloucester/King William/Mathews/Middlesex
34. Hampton/Newport News/Poquoson
35. Isle of Wight/Suffolk/Surry
36. James City/York
37. King George/Lancaster/Northumberland/Richmond/Westmoreland
38. Norfolk/Portsmouth
39. Virginia Beach

NORTH CAROLINA SITES

40. Beaufort/Hyde
41. Bertie/Camden/Chowan/Pasquotank/Perquimans/Tyrrell/Washington
42. Brunswick
43. *Carteret (South of Morehead City)
44. *Carteret (Morehead City north)
45. Craven/Pamlico
46. Currituck
47. *Dare (South of Mann's Harbor)
48. *Dare (Mann's Harbor north)
49. New Hanover/Onslow/Pender

SOUTH CAROLINA SITES

50. Beaufort/Colleton/Jasper
51. Charleston
52. Georgetown
53. Horry

GEORGIA SITES

54. Bryan/Chatham/Liberty
55. Camden
56. Glynn
57. McIntosh

EAST FLORIDA SITES

58. *Brevard (South of Melbourne)
59. *Brevard (Melbourne north)
60. Broward
61. *Dade (South of Coral Gables)

62. *Dade (Coral Gables north)
63. Duval/Nassau
64. Flagler
65. Indian River/Martin/St. Lucie
66. Palm Beach
67. St. Johns
68. *Volusia (South of Daytona Beach)
69. *Volusia (Daytona Beach north)

Appendix B: Questionnaire

Recreational Fishing Follow-up Survey, UMCP, Q15, Jan. 21, 1988

ENTER YOUR INTERVIEWER ID NUMBER.
ENTER THE CALL RECORD ID NUMBER.
ENTER THE FOLLOWING INFORMATION FROM THE LABEL:

- INTERVIEWER CODE
- MONTH
- DATE
- YEAR
- INTERVIEW NUMBER
- STATE CODE
- COUNTY CODE
- SEX
- AGE

INTRODUCTION

Hello, may I speak with ________.

(IF RESPONDENT IS NOT AVAILABLE, ASK FOR BEST TIME TO CALL BACK.)

Hello, my name is _______ and I'm calling long distance from KCA Research. We are the firm conducting the survey of saltwater recreational fishermen. According to our records, a member of our field staff interviewed you on (MONTH, DATE).

I'm calling you today for a follow-up survey being sponsored by the Environmental Protection Agency. They are interested in studying the choice of fishing locations by fishermen.

RESULT CODES

01 Busy
02 No answer
03 Nonworking number
04 Business--no one by that name
05 Household--no one by that name
06 Household--no longer lives at number
07 Claims never to have been intercepted
08 Could not reach in 3 attempts
09 Communication barrier
10 Initial refusal--Does not get to Q. 15a/16
11 Mid-interview refusal--Does not get to Q.50
12 Complete interview

1. To help me assign your information to a location, what is the ZIP Code of your principal residence?

Don't know	99998
Refused	99999

2. For this survey, we're interested only in the saltwater recreational finfishing trips you took during the months of _____ and _____ on the Atlantic Coast between New York and Florida, not including the Florida Keys. During the months of _____ and _____ how many local or one-day saltwater recreational finfishing trips did you take on the Atlantic Coast from your principal residence?

ENTER NUMBER. → IF NONE, GO TO Q. 16.

3. When our field interviewer spoke with you, were you on a one-day fishing trip or was that day of fishing part of a longer trip in which you spent at least one night away from your principal residence?

One-day	1	GO TO *.
Longer	2	
Don't know	3	GO TO **.
Refused	4	

* Now I'm going to ask a series of questions about each of your one-day saltwater recreational finfishing trips, beginning with the trip on which our field interviewer spoke with you.

** Now I'm going to ask a series of questions about each of your one-day saltwater recreational finfishing trips, beginning with the trip closest to the end of ______.

(FOR UP TO FOUR TRIPS, ASK Q's 4 - 15.)

4. In what state and county was (that/your next different) one-day saltwater recreational finfishing trip?

(LOCATION CODES.)

5. Did you fish primarily from a pier, bridge or other man-made structure, from a beach or bank, from a partyboat or headboat, from a charter boat, from a rental boat, or from a private boat?

Pier, bridge or other man-made	1
Beach or bank	2
Partyboat or headboat	3
Charter boat	4
Rental boat	5
Private boat	6
Other (Specify)	7
Don't know	8
Refused	9

6. Did you fish primarily in the ocean, in a sound, river, bay or inlet?

Ocean	1
Sound	2
River	3
Bay/Intracoastal Waterway	4
Inlet/Lagoon	5
Other (Specify)	6
Don't know	7
Refused	8

7. Were you fishing for any particular kind of fish that day?

Yes	1	
No	2	GO TO Q. 9.
Don't know	3	GO TO Q. 9.
Refused	4	GO TO Q. 9.

8. Which of the following best describes your target species--big game fish such as billfish, marlin, or tuna; small game fish such as bluefish, striped bass, or mackerel; flatfish such as flounder; or bottomfish, other than flatfish, such as croaker or spot?

Big game	1
Small game	2
Flatfish	3
Bottomfish	4
Other (Specify)	5
Don't know	6
Refused	7

9. How many other members of your household went with you on that fishing trip?

ENTER NUMBER.

Don't know	8
Refused	9

10. To the nearest mile, how many one-way miles was it from your home to the fishing or boat launch site? (IF MORE THAN 200, ASK: That's one-way miles? IF YES, ASK: This is a one-day trip from your principal residence?)

ENTER NUMBER.

Don't know	998
Refused	999

11. How many minutes did it take you to travel one-way from your home to the fishing or boat launch site?

ENTER NUMBER.

Don't know	998
Refused	999

12. (IF Q. 5 = 3, 4, 5 OR 6, ASK:) How many minutes did it take you to travel from the boat launch site to the first fishing site?

ENTER NUMBER.	
Don't know	998
Refused	999

13. To the nearest dollar, how much did it cost you (and your household members) to travel roundtrip from your home to the fishing or boat launch site? Include the cost of gas for your car, tolls, ferry and parking fees.

ENTER NUMBER.	
Don't know	9998
Refused	9999

14. (FOR EACH CATEGORY, ASK:) To the nearest dollar, how much did it cost you (and your household members) for ______ for that day of fishing?

A. bait
B. fish cleaning, processing and ice
C. fishing equipment rental
D. the purchase of fishing tackle and equipment
E. (IF Q. 5 = 1, ASK:) pier fees
F. (IF Q. 5 = 3 OR 4, ASK:) party or charter boat fees
G. (IF Q. 5 = 5, ASK:) boat rental
H. (IF Q. 5 = 5 OR 6, ASK:) boat fuel
I. (IF Q. 5 = 6, ASK:) boat launching fees

ENTER NUMBER.	
Don't know	9998
Refused	9999

(IF Q. 2 = 1, GO TO Q. 16.)

15. Of the (RESPONSE TO Q. 2) one-day finfishing trips you took during the months of _____ and ______, how many were like the trip you just described in terms of state and county of fishing (RESPONSE TO Q. 4) and type of fishing (RESPONSE TO Q. 5)?

ENTER NUMBER.

(IF Q. 15 < Q. 2, RETURN TO Q. 4.)
(IF Q. 15 = Q. 2, GO TO Q. 16.)

[NOTE: DO NOT ABORT AFTER ONE TRIP IS DESCRIBED THROUGH Q. 14.]

16. During the months of _____ and _____ did you take any overnight trips on the Atlantic Coast between New York and Florida, not including the Florida Keys, which did include at least one day of saltwater recreational finfishing? By overnight, I mean a trip in which you spent at least one night away from your principal residence.

Yes	1
No	2
Don't know	3 → GO TO Q. 40.
Refused	4

[NOTE: IF Q. 2 = 0 AND Q. 16 > 1, SAY: Our records show that you had at least one fishing trip during the months of _____ and _____--the trip on which our field interviewer spoke with you. Was that a local trip or was that a trip on which you spent at least one night away from your principal residence? BACKSTEP TO CORRECT PREVIOUS RESPONSE.]

17. How many such overnight trips did you take during the months of _____ and _____?

ENTER NUMBER.

18. I have a series of questions to ask you about the ~~overnight trip~~ you took closest to the end of _______. Again, that would be a trip in which you spent at least one day saltwater recreational finfishing. First, in what state and county did you do the majority of your fishing during that overnight trip?

(LOCATION CODES.)

19. Out of the last five years, how many years have you taken fishing trips to that state and county?

ENTER NUMBER.

Don't know	8
Refused	9

20. How many other members of your household were with you on the overnight trip you took closest to the end of _______?

ENTER NUMBER.

Don't know	8
Refused	9

21. What type of transportation did you use to travel from your principal residence to your overnight lodgings?

Automobile	1
Airplane	2
Bus	3
Train	4
Other (Specify)	5
Don't know	6
Refused	7

22. To the nearest hour, how many hours did it take you to travel one-way from your home to those lodgings? Include all hours--from the time you left your home to the time you arrived at your lodgings.

ENTER NUMBER.	
Don't know	98
Refused	99

23. To the nearest dollar, what were your roundtrip travel costs from your residence to those lodgings? Include any lodging or motel costs you had on the way. (IF APPROPRIATE, ADD: Include the costs of all members of your household who went on this overnight trip.)

ENTER NUMBER.	
Don't know	9998
Refused	9999

24. In what type of lodgings did you stay, at or near your primary fishing site?

Hotel/Motel	1
Rental home or condo	2
Private home of friend or relative	3
Tent or RV	4
Boat	5
Personal second home	6
Other (Specify)	7
Don't know	8
Refused	9

25. Was the primary purpose of this trip for fishing, for general vacation, for business, or what?

Fishing	1
General vacation	2
Business	3
Other (Specify)	4
Don't know	5
Refused	6

26. How many days during _____ and _____ were you away from your principal residence on this trip?

ENTER NUMBER.

27. Of the <u>(RESPONSE TO Q. 26)</u> days you were away from home during _____ and _____ on this trip, on how many days did you spend at least some time saltwater recreational finfishing?

ENTER NUMBER.

(FOR UP TO THREE DAYS, ASK Q's 28 - 39.)

28. On the (first/next different) day of fishing did you fish primarily from a pier, bridge or other man-made structure, from a beach or bank, from a partyboat or headboat, from a charter boat, from a rental boat, or from a private boat?

Pier, bridge or other man-made	1
Beach or bank	2
Partyboat or headboat	3
Charter boat	4
Rental boat	5
Private boat	6
Other (Specify)	7
Don't know	8
Refused	9

29. Did you fish primarily in the ocean, in a sound, river, bay or inlet?

Ocean	1
Sound	2
River	3
Bay/Intracoastal Waterway	4
Inlet/Lagoon	5
Other (Specify)	6
Don't know	7
Refused	8

30. Were you fishing for any particular kind of fish that day?

Yes	1	
No	2	GO TO Q. 32.
Don't know	3	GO TO Q. 32.
Refused	4	GO TO Q. 32.

31. Which of the following best describes your target species--big game fish such as billfish, marlin, or tuna; small game fish such as bluefish, striped bass, or mackerel; flatfish such as flounder; or bottomfish, other than flatfish, such as croaker or spot?

Big game	1
Small game	2
Flatfish	3
Bottomfish	4
Other (Specify)	5
Don't know	6
Refused	7

32. (IF Q. 20 > 0, ASK:) How many other members of your household went with you on that day of fishing?

ENTER NUMBER.	
Don't know	8
Refused	9

33. To the nearest mile, how many one-way miles was it from your overnight lodgings to the fishing or boat launch site? (IF MORE THAN 200, ASK: That's one-way miles from your overnight lodgings?)

ENTER NUMBER.
Don't know 998
Refused 999

34. How many minutes did it take you to travel one-way from your lodgings to the fishing or boat launch site?

ENTER NUMBER.
Don't know 998
Refused 999

35. (IF Q. 28 = 3, 4, 5 OR 6, ASK:) How many minutes did it take you to travel from the boat launch site to the first fishing site?

ENTER NUMBER.
Don't know 998
Refused 999

36. To the nearest dollar, how much did it cost you (and your household members) to travel roundtrip from your lodgings to the fishing or boat launch site? Include the cost of gas for your car, tolls, ferry and parking fees.

ENTER NUMBER.
Don't know 9998
Refused 9999

37. (FOR EACH CATEGORY, ASK:) To the nearest dollar, how much did it cost you (and your household members) for ______ for that day of fishing?

A. bait
B. fish cleaning, processing and ice
C. fishing equipment rental
D. the purchase of fishing tackle and equipment
E. (IF Q. 28 = 1, ASK:) pier fees
F. (IF Q. 28 = 3 OR 4, ASK:) party or charter boat fees
G. (IF Q. 28 = 5, ASK:) boat rental
H. (IF Q. 28 = 5 OR 6, ASK:) boat fuel
I. (IF Q. 28 = 6, ASK:) boat launching fees

ENTER NUMBER.
Don't know 9998
Refused 9999

38. (FOR FIRST DAY OF FISHING ONLY, ASK:) If your costs for fishing on this day had increased by ______, would you still have gone fishing on that day?

A. $5
B. $15
C. $30
D. $50
E. $75
F. $100
G. $150
H. $200

Yes	1
No	2
Don't know	3
Refused	4

(IF Q. 27 = 1, GO TO Q. 40.)

39. How many of the (RESPONSE TO Q. 27) days you went finfishing on this overnight trip were like the one you just described in terms of type of fishing (RESPONSE TO Q. 28)?

ENTER NUMBER.

(IF Q. 39 < Q. 27, RETURN TO Q. 28.)
(IF Q. 39 = Q. 27, GO TO Q. 40.)

40. How many years have you been saltwater recreational finfishing?

ENTER NUMBER.
Don't know 98
Refused 99

41. If you were offered a check for (LIST 1) to give up saltwater recreational finfishing (LIST 2), would you accept it?

List 1:

1 $5
2 $10
3 $20
4 $30
5 $50
6 $70
7 $80
8 $100
9 $200
0 $500

List 2:

1 anywhere on the Atlantic Coast between New York and Florida, not including the Florida Keys, for the next year
2 anywhere on the Atlantic Coast between New York and Florida, not including the Florida Keys, for the next two months
3 anywhere in the state in which our field interviewer spoke with you for the next year
4 anywhere in the state in which our field interviewer spoke with you for the next two months

Yes	1	
No	2	
Don't know	3	GO TO Q. 43.
Refused	4	GO TO Q. 43.

42. How sure are you of that answer? Are you very, somewhat, not too, or not at all sure of your answer?

Very sure	1
Somewhat sure	2
Not too sure	3
Not at all sure/Don't know	4
Refused	5

43. Does any member of your household own a second home?

Yes	1	
No	2	GO TO Q. 45.
Don't know	3	GO TO Q. 45.
Refused	4	GO TO Q. 45.

44. To the nearest mile, how many miles is that second home from saltwater on the Atlantic Coast between New York and Florida, not including the Florida Keys?

ENTER NUMBER.

Don't know	9998
Refused	9999

45. Does anyone in your household own a boat that is used for saltwater recreational finfishing on the Atlantic Coast between New York and Florida, not including the Florida Keys?

Yes	1	
No	2	GO TO Q. 50.
Don't know	3	GO TO Q. 50.
Refused	4	GO TO Q. 50.

46. During the fishing season, is the boat kept in the water?

Yes	1	
No	2	GO TO Q. 48.
Don't know	3	GO TO Q. 48.
Refused	4	GO TO Q. 48.

47. In what state and county is it kept?

(LOCATION CODES.)

48. To the nearest dollar, what are the annual costs of owning this boat? Include slip rental, insurance, and maintenance and repair.

ENTER NUMBER.

Don't know	9998
Refused	9999

49. If you were to sell this boat, how much do you think you could get for it?

Less than $500	01
$500 to less than $1,000	02
$1,000 to less than $2,500	03
$2,500 to less than $5,000	04
$5,000 to less than $7,500	05
$7,500 to less than $10,000	06
$10,000 to less than $15,000	07
$15,000 to less than $20,000	08
$20,000 to less than $40,000	09
$40,000 to less than $60,000	10
$60,000 to less than $80,000	11
$80,000 to less than $100,000	12
$100,000 or more	13
Don't know	14
Refused	15

[NOTE: COMPLETE INTERVIEW.]

50. Including yourself, how many people reside in your household?

ENTER NUMBER.	
Don't know	98
Refused	99

51. Are you currently employed?

Yes	1	
No	2	GO TO Q. 57.
Don't know	3	GO TO Q. 57.
Refused	4	GO TO Q. 57.

52. Do you work for an hourly wage or for a salary?

Hourly wage	1	
Salary	2	GO TO Q. 54.
Commission only	3	GO TO Q. 54.
Self-employed	4	GO TO Q. 54.
Other (Specify)	5	GO TO Q. 54.
Don't know	6	GO TO Q. 54.
Refused	7	GO TO Q. 54.

53. To the nearest dollar, what is your hourly wage?

ENTER NUMBER.	
Don't know	998
Refused	999

54. How many hours a week do you usually work?

ENTER NUMBER.	
Don't know	98
Refused	99

55. (IF Q. 52 > 1, GO TO Q. 56.) Can you choose to work more or fewer hours a week?

Yes	1
No	2
Don't know	3
Refused	4

56. How many paid vacation days have you earned in the past 12 months?

ENTER NUMBER.	
Don't know	98
Refused	99

57. Which of the following best describes your total annual household income, before taxes? Is it less than $15,000, $15,000 to $30,000, $30,000 to $45,000, $45,000 to $60,000, $60,000 to $75,000, $75,000 to $90,000, or $90,000 or more?

Less than $15,000	1
$15,000 to $29,999	2
$30,000 to $44,999	3
$45,000 to $59,999	4
$60,000 to $74,999	5
$75,000 to $89,999	6
$90,000 or more	7
Don't know	8
Refused	9

That concludes this interview. A number of fishermen will be contacted again in the next six to eight weeks for a follow-up survey concerning their _____ and ______ fishing trips. Thank you for your time and cooperation.

Appendix C

In the course of estimating the model and calculating welfare effects, we have made numerous research judgements that have influenced the results. To test the effect of these models on the parameter estimates we have done a few sensitivity tests on a small data set. This data set contained 240 observations compared with 5500 from the full analysis. The small size of the data set enabled nested models to be estimated in our program.

With this data set, we estimated models and calculated welfare effects various ways of calculating costs per trip. The basic model is

(B.1) $$\beta_1 \text{ cost} + \beta_2 \text{ time} + \beta_3 \log m + \beta_4 \text{ boat} + \beta_5 Q_{bg}^{1/2} \text{ bg} + \beta_6 Q_{sg}^{1/2} \text{ sg}$$

where these variables are defined in the text. Recall that cost is calculated as

round trip miles × travel cost/mile + interior × wage rate × round trip travel time

where interior = 1 if the person can work additional hours for additional wages. We have varied travel cost per mile and wage rate. Sensitivity is measured by the coefficient on the travel cost and a welfare estimate. We use the access value for New York as a barometer of welfare measures, though the results would be the same for other states. Table C.1 shows the various results.

Table C.1 Sensitivity to travel and time costs: Ratio of welfare measure relative to the base case[a]

	Travel costs per mile		
Time costs per hour of travel time	\$.20	\$.15	\$.10
wage rate	1	.88	.77
½ wage rate	.72	.61	.50

[a]The base case is full wage rate, \$.20 per mile. The welfare measure is the access value for New York. The ratio is cell value base case value.

Basically, Table C.1 shows a linear effect. When costs are reduced by 50%, the value of access is reduced by 50%. Single changes, in the direction of wage rates or costs per mile, bring smaller proportional changes. The sensitivity analysis in this table is likely to bound reasonable differences about time and travel costs.

We performed several other sensitivity analyses. In addition to the changes in time and travel costs given above, we estimated a model without a separate time variable. This model, just equation B.1 above without time ($\beta_2 = 0$) gave a ratio of .64 relative to the base case.

For all the sensitivity analyses, there was very little change in any of the other parameters (β_3 - β_6) or the coefficient on inclusive value.

Three additional sensitivity tests were performed. First, we estimated parameters and calculated welfare using log (Q_{ms}) rather than $Q_{ms}^{1/2}$. This had no effect on welfare, though of course the coefficients of the Q's would change because of the difference in scale between log Q_{ms} and $Q_{ms}^{1/2}$.

Responding to comments on our initial draft, we attempted to include four measures of the supply of facilities for recreational fishing. The measures at the site level were

1. number of slips
2. number of fishing piers
3. number of docks
4. number of boat ramps.

These variables were introduced in a variety of ways. For example, boat ramps was interacted with a dummy variable indicator for the private rental mode. Regardless of how these variables were included in the model, these coefficients were typically insignificant or negative in sign.

Finally, we tested the definition of the choice set. Our results determine the choice set in the following way:

1. For an angler who lives more than 30 miles from shore, all sites within 400 miles are eligible.

2. For anglers living within 30 miles of the shore, any site within 150 miles is eligible. This definition is based on our intuitive sense of behavior. We think it less likely that anglers would drive long distances up and down the coast to fish. We tested this by defining everyone's choice site as all sites within 400 miles. This had the effect of making the catch rate variables less significant, with no changes in the other variables. This makes sense; anglers are less likely to respond to catch rates from sites not relevant in their decision.

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