The Economic Value of Marine Recreational Fishing in the Southeast United States

1997 Southeast Economic Data Analysis

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Chapter 1
Introduction

The purpose of this report is to estimate economic values associated with access to fishing sites and the quality of marine recreational fishing in the United States from North Carolina to Louisiana. We use data from the Marine Recreational Fishery Statistics Survey (MRFSS) combined with the Add-On MRFSS Economic Survey (AMES). The two datasets describe where anglers fish, the fish they catch, and their personal characteristics. When anglers choose among recreational sites, they reveal information about their preferences. The basic approach of the report is to use that information to infer their economic values for site access and site characteristics.

In the context of marine recreational fishing, the quality of the fishing at different sites is a critical characteristic. We use two measures of fishing quality. The first measure is the species, mode, and wave-specific 5-year historic (targeted) catch and keep rates per trip at each site. The second is the expected (targeted) catch and keep rate per trip from household production models, conditional on the historic (targeted) catch and keep rates, targeted species, fishing mode, and time period.

Angler behavior is estimated with the nested random utility model (NRUM) for single day trips. Anglers (who have already chosen to take a single day trip) are assumed to choose fishing mode and target species and then choose where to fish. The determinants of site choice include the site-specific cost and the quality of the fishing trip. The NRUM allows the estimation of the probability of site visitation under various situations. We combine these probabilities with visitation data obtained from the AMES to estimate the value to anglers of sites, species and mode-specific trips taken each wave.

We estimate three types of economic values. The first is the value of access to sites for individual anglers. The second is the value of access to species for individual anglers. The third is the value associated with various changes in the ability of anglers to catch fish. These changes might be caused by long run changes in fish stock densities, as proxied by historic catch rates. Such long run changes in fish densities could be due to increased fishing pressure or water pollution. Others will stem from policy measures, such as limits on the number of fish kept. Our ability to estimate the value of bag limits depends on the ability of the household production model to accurately estimate predicted catch rates and for predicted catch rates to help explain the site selection decision.

The rest of this report is organized as follows. In Chapter 2 we describe the random utility model theory. In Chapter 3 we describe the MRFSS-AMES data and the construction of variables for the NRUMs. In Chapter 4 we assess the effects of alternative distance and catch based choice sets. In Chapter 5 we present a nested random utility model of individual special-case species for a single fishing mode. In Chapter 6 we present the full nested random utility model of all species and modes. In Chapter 7 we offer some conclusions. Brief previews of each chapter follow.

In Chapter 2 we describe the random utility model theory. We begin with the choice models that we are assuming with a focus on what they capture (choice per trip per sampled individual) and what they miss (simultaneous choice of number of trips and substitution among seasons). We then describe the basic approach: mutually exclusive choices as a function of a set of small but critical attributes of the fishery; characteristics of fishing measured by the catch rate and the costs of fishing. Together these attributes, when properly fitted in the econometric model, can provide answers to some of the most important questions in recreational fishing. We also point out the important questions that cannot be answered with these data.

Next, a general description of the random utility model is provided. We then focus on the random utility model for the southeast fishery and the two cases of nested logits: the important species case (presented in Chapter 5) and the species group case (presented in Chapter 6). We then focus on issues surrounding measuring the catch rate, historic means versus individual catch rates, the role of individual heterogeneity, and the household production catch rate models for species and species groups.

Chapter 3 is devoted to a summary of the data in which variables from the MRFSS-AMES are examined to determine the optimal choice structure. The definition of choice structure depends on two factors: sufficiency of the data and practicality in estimation. The level of species aggregation in the first stage decision will depend upon the level of representation of each individual species in the AMES data, and the representation of each fishing mode in the economic data. The results from the initial data analysis are used to determine the targeted species at various levels of geographic aggregation, and to determine the optimal pattern of species aggregation. The two-stage choice structure, mode-species then site choice, is adopted as a goal for estimation.

Chapter 3 also provides a detailed explanation of our household production modeling of catch rate per trip. Two methods are used to predict the expected fishing quality (catch rates) for each angler's trips: Historic catch and keep rates and predicted catch and keep rates. Catch rates are defined based on aggregation of NMFS intercept sites at the county level. Historic (targeted) catch and keep rates at each site are used as a proxy for expected fishing quality. Count data models (Poisson and negative binomial models) are used to estimate expected catch and keep rates at each site for the relevant target species (group) for each angler by mode. Models of expected catch have the advantage to facilitating analysis of policy measures such as bag limits that influence the distribution of catch. This analysis is not feasible with historical catch rates. Expected keep rates are predicted for each individual site/species/mode choice and, when used in the RUM, are capable of analyzing the cost of bag limits.

In Chapter 4 we examine the optimal choice set structure for the second stage decision. The second stage choice structure represents the actual site chosen. Assessing the extent of the market allows us to determine the optimal site definition and sites that can be ruled out of choice sets for individuals who target species. The geographic extent of the market and site characteristics (catch) are used to determine the optimal size of the site choice set for small game, boat anglers. We then examine this choice set structure in the nested logit models for individual species (Chapter 5). In Chapter 4 we also compare models that use the two competing measures of site quality: historic mean and expected catch and keep rates. We also briefly discuss another comparison of two competing measures of catch rates. The first is the broad catch rate measure that includes fish caught and kept, released, or used for bait. The second is the more narrow harvest (fish caught and kept) rate.

In Chapter 5 we develop single species-site choice nested RUMs for important species. The MRFSS-AMES data supports individual analysis of at least two species: spotted seatrout and red drum. Due to the lack of sufficient data to estimate historic catch and keep rates and site selection patterns for other species of importance we develop species group models for coastal migratory pelagic fish (including king mackerel, Spanish mackerel) and snapper-grouper fish (e.g. red snapper, red grouper). We compare non-nested random utility models of site choice for individual species and species groups with a nested model of species-site choice. Welfare measures of site access, species access, and improvements in historic catch rates are developed.

In Chapter 6 we examine the two-stage choice structure in which anglers first choose a mode-species combination and then choose the fishing site. This model employs broad species groups: big game fish, small game fish, flat fish, and bottom fish. The fifth species group includes anglers who do not target fish (a large proportion of the southeast MRFSS anglers) and those who target other species. For each model estimated, the value of access to fishing sites, sub-divided geographically by state, is calculated. When appropriate, the value of access is estimated for fishing mode and species group (the value of species elimination).

In Chapter 7 we provide some conclusions from this research. We focus on the general results and how they can be extended and modified for more specific policy analysis. We also discuss the limitations that we encountered with the MRFSS-AMES data and make suggestions about future economic data collection efforts.

Chapter 2
Random Utility Models and Poisson Catch Rates

The Nature of the Model

In this chapter we describe the model of angler activity that leads to empirical estimates of angler preferences. In the context of marine recreational fishing, we are especially interested in two aspects of anglers' preferences: how they value access to specific sites and how they value the opportunity to catch different species of fish. Of course, anglers value many other aspects of fishingCfor example, the companionship of other anglers, the weather, the absence of boat or other type of gear problems. But these are too myriad and complex to include in an empirical model. Further, as long as these unmeasured and hence excluded variables are not correlated with the measured and included characteristics, these omissions will not influence our results.

To motivate a model of recreational fishing activity, consider an identity for the flow of total economic value of a recreational fishery, recognizing that we limit our discussion to economic value per unit of time that accrues to recreational anglers, and not to the suppliers of resources for the anglers. It is useful to begin with total economic value not only because it can lead us to models that estimate this value; but more important it shows how fishery policy and the marine environment change the value. By definition, the total economic value equals the number of participants in the fishery times the economic value per participant. The value per participant is the amount of money they would be willing to pay to secure the right to fish for the period of time in question. Typically economic values are computed on an annual basis, but due to the methods of data collection in the MRFSS, total economic value will be calculated by two-month time periods. The measure of total economic value excludes indirect effects such as sales of recreational goods, or taxes or employment effects. Then we define the value per angler as the product of the angler number of trips and the value per trip. This gives an identity for the total economic value:

(1) $\quad TEV = N*X*WTP$

Where TEV is total economic value, N is the number of participants, X is the number of trips, and WTP is the willingness to pay, or value, per trip.

This identity holds regardless of the behavior of individual anglers. We arrive at a plausible model of estimation by imposing some behavioral assumptions on the components of this identity. First, assume that the number of participants in the fishery is fixed. This is a plausible assumption in the short run. Historically the number of anglers responds slowly to demographic trends, circumstances in the fisheries, and competing opportunities for anglers. Next assume that the value per trip is independent of the number of trips. This imposes a specific structure on preferences (Morey, 1994). We now have a model that defines an angler's total economic value from recreational fishing (consumer surplus) as the product of a value per trip and the quantity of trips.

The factors that influence economic value that are measurable and of interest for policy analysis can be categorized as conditions of access, being primarily the costs of reaching fishing sites, and fishing conditions, which denote the species availability and abundance. Availability and abundance do not provide the same opportunities to all anglers. Some are more skilled and more able by virtue of where they live and their experience to take advantage of fishing opportunities. Hence angler characteristics comprise another set of determinants of the economic value per angler.

We can now formulate the economic model of behavior. Let c represent a vector of the conditions of access to sites, q a vector of the fishing opportunities at sites, and y a vector of individual characteristics. For example, c could represent all of the costs of reaching reasonable sites, q could represent the quality of the experienceCmean number and weight of different species caught or kept per trip, and y could indicate age, experience and ownership of capital goods used to catch fish (boats, rods, etc.). Now we write the model of value per angler as:

(2) $TEV/N = X(WTP(c,q,y),y)*WTP(c,q,y)$.

This formulation has a specific behavioral structure built into it. The number of trips depends on the value per trip and some individual characteristics.[1] The value per trip depends on costs of access, fishing circumstances, and individual characteristics. The structure of the model permits a two-stage estimation approach. First we could estimate a model that determines the value per trip. This will be the random utility model. We could then use the predicted value per trip along with some individual characteristics to estimate the number of trips per angler. Then we could take the product of the three quantities--total anglers, number of trips, and value per tripCto compute the total value of the fishery.

In practice, the model that we adopt is richer than this simple version. We allow behavior to vary geographically, so that anglers living in some regions of the southeast do not behave exactly the same as anglers in other regions. Further, fishing varies by season, so that models take some account of seasonal differences. Finally model construction is constrained by the sampling of individual anglers. The MRFSS has had the historical goal of estimating the total catch by species by two-month periods (denoted waves in NMFS nomenclature). Consequently, MRFSS sampling has focused on angler activity by waves. Our models reflect this focus on waves and instead of estimating the total annual value of the fishery, we estimate the total value per wave.

The assumptions made to accommodate the MRFSS sampling scheme and the estimation requires model construction that restricts behavior in two significant ways. First, individuals do not substitute among waves. For example, an improvement in

[1] Note that all y's need affect value per trip or the number of trips.

fishing in one wave will result in changes in fishing activities during that wave, but will leave unchanged activities during other waves. This typically will result in underestimates of the economic value of improvements in fishing circumstances, and overestimates of the economic value of declines in such circumstances. Second, the structure of the model forces the change in fishing circumstances to change the value per trip, and that changes the number of trips. Direct influence of fishing costs and circumstances on the number of trips is eliminated by assumption. It is less clear whether this assumption biases estimates of the value of changes in fishing circumstances.[2] When properly fitted, the econometric models will answer some significant questions about recreational activities and values in the Southeast, but naturally leave some questions not addressed.

The Detailed Structure of the Model

The nature of the MRFSS sampling and the structure of the model leads to the random utility model as a means of uncovering preferences. Individual anglers are intercepted at NMFS sites throughout the Southeast. At the intercept, interviewers determine where the angler came from, some minimal information on the individual's characteristics, and weigh and measure the angler's catch. Thus the interviewer obtains some components of c, q, and y. The angler has arrived at the site by choosing among a set of feasible sites.

The random utility model assumes that the individual angler makes a choice among mutually exclusive alternatives based on the attributes of the alternatives. In essence, the only thing that matters to the angler is the set of measured attributes of the sites. Two sites that have the same attributes are identical and provide the same utility to the individual. The choice of sites is determined by utility maximization. Let $u_j(k)$ represent the utility that angler k gets from a trip to site j. Let the number of feasible choices (the number of sites) be denoted J. In applications, we will allow J to vary by angler, so that J in concept will be subscripted with k. Without restrictions of the choice set, each angler would choose among the 70 sites defined for the Southeast.[3] Angler k will choose site j if $u_j(k)>u_h(k)$ for $h = 1,Y,J$ and $h \ldots j$. The random utility model comes from supposing that the researcher can observe behavior that relates only to a part of the utility function, and that there is a random part that is not related to behavior and hence not recoverable. When the deterministic part and the random part are additive, and the random part is distributed as an extreme value variate, we arrive at the conditional logit model. Suppose utility is given by

(3) $u_j(k) = v_j(k) + \varepsilon_j$

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[2] Parsons, Jakus and Tomasi (1999) discuss the integration of the value per trip and number of trips in detail.

[3] MRFSS sites are aggregated into 77 county level zones. Seventy of these zones are represented in the AMES data.

where $v_j(k)$ is the deterministic part of utility and the stochastic part ε_j is a type I extreme value distributed variate with mean zero and constant variance. Then the individual angler still maximizes utility, but the probability that the angler chooses site j is the probability that $u_j(k) > u_h(k)$ for h = 1,Y,J and h...j and for the extreme value distribution this becomes

(4) Prob(angler k chooses site j) = $\exp[v_j(k)]/\Sigma_h \exp[v_h(k)]$.

When $v_j(k)$ is given parametric form and observable and measurable arguments, the parameters of the utility function can be estimated. This is the conditional logit model as originally conceived by McFadden (1974). Many variants of this model have been estimated for consumer choice in transportation, recreation, and many other areas. This simple form of the probability exhibits the property of independence of irrelevant alternatives (IIA), which means intuitively that the odds that an angler will choose site a over site b will not depend on the attributes of other sites. This is a particularly difficult property to accept, because it means that if we were to add another site, say site c, which was identical to b, it would not change the odds of choosing between a and b.

In our applications below, we use a more general model, a form of the nested logit (McFadden, 1978). To illustrate the general case, suppose that as before, the index j refers to sites, and that we have another choice, the mode/species choice. The motivation for this model is that the angler chooses what kind of species to seek and what kind of mode to fish jointly. The modes are shore fishing, fishing from party or charter boats, and fishing from private or rental boats. The species groups are big game, small game, bottom fish and flatfish (flounder, fluke and other flounder like species). A disadvantage of this choice sequence is illustrated in the Southeast data, where more than 50% of the anglers give no preference for species. A separate category for anglers who do not seek a species or species group will be created to manage this set of anglers.

In the mode/species-site choice model, the angler determines where the best possibilities for this kind of fishing take placeCthat is which sites have the best opportunities for the given mode/species combination. For example, an angler who targets red drum (in the small game species group) from the shore in the fall would choose a site where the evidence suggests reasonable success in catching red drum. Let the mode/species index be denoted m=1,Y,M. Then suppose that utility can be written

(5) $u_{jm}(k) = v_{jm}(k) + w_m(k) + \varepsilon_{jm}$ for j = 1,YJ; m = 1,Y,M

where deterministic utility is divided into two parts: v_{jm} is the part that depends on where anglers fish and what mode/species group they target and w_m depends only on the mode/species group they target. The probability that an angler chooses the particular combination of mode/species m and site j is the probability that this (j,m) gives the maximum utility:

(6) Prob(angler k chooses j,m) = Prob($v_{jm}(k) + w_m(k) + \varepsilon_{jm} > v_{hn}(k) + w_n(k) + \varepsilon_{hn}$)

for œ h…j and œ n…m.

The form of this probability depends on the distribution of the stochastic portion of preferences. Because of its greater generality, and because it mitigates the independence of irrelevant alternatives assumption, the generalized extreme value is the most appropriate distribution for the nested model.[4] Suppressing the angler index temporarily, we can write the joint probability of choosing (j,m) as the product of the marginal and the conditional:

(7) Prob(j,m)=Prob(j|m)Prob(m).

When the stochastic part of preferences has a generalized extreme value distribution, the conditional probability of choosing site j, given mode/species group m is given by

(8) $\text{Prob}(j|m)=\exp(v_{im}/\theta)/\Sigma_h \exp(v_{hm}/\theta)$

where θ is a parameter of the generalized extreme value distribution. The marginal probability of choosing mode/species m is given by

(9) $\text{Prob}(m) = \exp(w_m + \theta I_m)/\Sigma_n \exp(w_n + \theta I_n)$

where I_m is the inclusive value, defined as $I_m = \ln(\Sigma \exp(v_{jm}/\theta))$. When θ=1, the generalized extreme value distribution collapses to the type I extreme value. Rejection of the hypothesis that θ=1 can be taken as support of the appropriateness of the nested logit model. When v_{jm} and w_m are written as linear in parameter models of attributes, the general utility function can be estimated in two steps. First estimate the parameters in the Prob(j|m) model. These parameters will be normalized by θ. Then estimate the parameters in the Prob(m) equation, with the parameters of w_m and θ. The sequential estimation procedure will produce inconsistent standard errors however. This difficulty can be overcome by correction of the standard errors or by simultaneous estimation.[5]

There are solid theoretical and econometric reasons for specifying the decision process as choice of mode/species, site, with the stochastic component distributed generalized extreme value. In this model, the angler makes two choices: mode/species and site. A plausible alternative model would have the angler simply choose the site, letting the mode/species determination be exogenous. To compare the two approaches to modeling choices, we construct reasonable but simple parametric versions of the utility

[4] See Morey (1999) for a discussion of the types of extreme value distributions and the implied choice probabilities.
[5] We do not pursue these correction in this report.

functions. For the nested model, the deterministic utility function is given by

(10) $v_{jm}(k)= \beta c_j(k) + \gamma_m q_{jm}(k)$

where now $c_j(k)$ is the travel cost to site j for angler k, and $q_{jm}(k)$ is the expected catch or other attributes of the species in mode/species category m at site j for angler k.[6] In this model, β can be interpreted as the negative of the marginal utility of income. Income itself has been dropped for the sake of simplicity, because in this case of constant marginal utility of income, it has no influence on choices. This model allows the different mode/species attributes to have different marginal utilities because the parameter γ is given a subscript m. The probability of choosing site j with this model is given by (assuming a generalized extreme value stochastic component)

(11) $\mathrm{Prob}(j|m) = \exp[(\beta c_j(k) + \gamma_m q_{jm}(k))/ \theta]/\Sigma_h \exp[(\beta c_h(k) + \gamma_m q_{hm}(k))/\theta]$.

Note that the choice of site given the mode/species combination depends only on the species in question. Suppose instead we dispense with the mode/species choice and let the anglers choose site only. A reasonable way to let them choose would be to have them enjoy the possibility of catching any of the species. That is, we could write the deterministic part of the utility function:

(12) $v_i(k)= \beta c_j(k) + \Sigma\lambda_n q_{jn}(k)$.

This preference function would imply that the probability of choosing site j is:

(13) $\mathrm{Prob}(j) = \exp[\beta c_j(k) + \Sigma\lambda_n q_{jn}(k)]/ \Sigma_h \exp[(\beta c_h(k) + \Sigma\lambda_m q_{hm}(k)]$.

The theoretical advantages of the nested structure become apparent when we compare the two probabilities. If an angler truly has a species preference, this model would attribute utility to the angler for a species that he is not seeking. And conceptually, the simple site choice model imposes the IIA assumption, unless the stochastic component of utility has been given a special structure among sites. Econometrically the nested site choice model has the great advantage that given the mode species choice, the choice among sites depends on only one mode/species attributeCq_{jm}Cinstead of the whole set of mode/species attributes in the simple site choice model. The collinearity induced by attempting to estimate the whole set of parameters for each angler would make the parameter estimates imprecise and unstable.

A third alternative, not outlined here, would have the angler choose simultaneously from each site, mode, and species, so that each site, mode, species comprises a separate alternative. This is an unwieldy modeling option because it implies that each angler faces approximately 1000 choices for each choice occasion.

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[6] We ignore for the moment the mode/species component of utility.

Consequently we adopt the mode/species, site choice as a means of modeling the fishery and understanding the impact of policy changes. In the applications, we will estimate two kinds of nested models: one in which the species groups are aggregated, and a second in which the angler chooses among distinct species.

Model Specification: The Role of Fishing Characteristics

The chief purpose of this research is to develop a model of recreational fishing activity that is sensitive to changes in fishing circumstances to answer questions about fisheries policy that impact the quantity and types of species that are available to recreational anglers. This purpose makes the choice of variables that represent the availability and abundance of different species, through which policy will make itself felt, critical to the model.

The measures of the attractiveness or the abundance of the species/species groups, the $q_{jm}(k)$, are a compromise between what is desirable from the perspective of fishery management and angler behavior, and what is practical in terms of econometrics and the availability of data. Almost all models of recreational fishing ultimately use some type of catch rate, that is the number or weight of fish caught per unit of time or per fishing trip, a one-dimensional variable.[7] As the sole measure of the quality of fishing at a site, the daily catch or catch rate does not provide information about the size of the fish or the likelihood of catching a trophy-size fish. One fish caught could be a 2 pound weakfish or 20 pound snook, both small game fish, but unlikely to provide the same enjoyment to anglers. 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. Other things equal, more fish is preferred to fewer fish, and increased stock densities typically make more fish available.

There are essentially three ways to calculate a catch rate. One is from the actual catch of the angler for the day. This has the virtue that it surely increases the angler's utility, but it is also determined in part by random elements for the trip. With sufficient randomness, this catch rate cannot be viewed as an *ex ante* measure of fishing quality at the site. The second approach is to calculate the average catch by all anglers at the site over the historical record, which can be 5 to 10 years for some NMFS intercept data. This measure has good qualities and is frequently used. It is truly exogenous to the individual angler, it should respond positively to increases in stock densities, and should be a proxy for some desirable characteristics of the fishery. In the estimation of models from MRFSS data, the historical catch rate is an attractive option because the MRFSS data-gathering effort has resulted in the compilation of time-series catch data for many coastal regions. For example, McConnell and Strand (1994) use historical catch rates in random utility models in a study of recreational fishing in the middle Atlantic states.

[7] See McConnell, Strand and Blake-Hedges (1995) for a discussion of various measures of fishing success.

In practice, the MRFSS offers the choice between catch data and catch and keep data. The catch and keep data represent the fish that are available for measurement, while the catch data represent in addition to the catch and keep, fish that are released, used for bait or not available for measurement for other reasons. In some cases, the catch, and not the keep data, provide a more suitable measure of what anglers wish to catch. For example, tarpon are always released, and so anglers who would care a lot about catching tarpon, would never keep them. In other cases, the fish not kept may be undesirable due to size or species. Given the greater error associated with the unobserved catch, we opt for the catch and keep data.[8] And in our discussions below, this is the catch data that we refer to.

An alternative to the historical catch rate is the estimated catch rateCfor example with a Poisson model. There are several advantages of a predicted model of catch over the historical catch. First, it allows individual covariates such as boat ownership or fishing experience to influence the catch, rather than impose the same expectations on different anglers. An angler with a great deal of fishing expertise would reasonably have different expectations about catching fish than a novice. Second, the predicted catch rate stems from randomness in the catch rate equation, and this randomness can be viewed as the random process of catching fish. Other moments could also be calculated and used as arguments in the preference function. Further, a predicted catch model represents a superior means of imposing policy measures such as bag limits. For example, suppose there is proposed limitation of keeping more than two of a species. In a historical catch model, this policy measure must be imposed by restricting the catch rate of all anglers by the same proportion. In the predicted catch model, the bag limit can be used to impose an upper truncation limit on the distribution of catch, and from that a new expected catch can be calculated.
[9] Hence the predicted catch and keep model provides a means of modeling policy scenarios that other measures of catch do not permit.

In the process of catching fish, the number of fish caught is a random variable whose distribution depends on policy variables and individual attributes. An angler's catch of fish per trip is influenced by many factors. The abundance of fish, the mode of fishing (e.g., boat, shore or pier), type of gear and baits, the tidal situation, the weather, water clarity and temperature, the age and experience of an angler, and the hours fished all influence catch. Data availability limits our empirical model. We model the total number of fish caught per trip, Q, but assume that utility depends on the catch rate, q, the number of fish caught per hour, Q/h. This specification gets the essential ingredients, fish and time, into the utility function. We assume that the distribution of fish caught is Poisson:

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[8] See Haab and Whitehead (1999) for a comparison of models using historic catch and historic catch and keep rates.
[9] See for example McConnell, Strand and Blake-Hedges (1995).

(14) $P(n) = Q^n e^{-Q}/n!$ for n = 0, 1, ..., 4

where P(n) is the probability of catching n fish and Q, the mean total catch depends on household and site characteristics. The mean of this process, the expected number of fish caught per trip, equals:

(15) $E(n) = Q.$

To illustrate with a specific form, suppose that

(16) $Q_{jk} = \exp(a_0 + a_1 HKCR_j + a_2 HRFS_k + a_3 s_j + a_4 d_k)$

where

Q_{jk} = number of fish caught at site j by angler k;
$HKCR_j$= historic mean catch and keep rate at site j;
$HRFS_k$= hours spent at the site by angler k;
s_k = skill or experience in saltwater fishing by angler k.
d_k = indicator variable for mode, species or perhaps season.

When $a_2 = a_3 = a_4 = 0$, individual differences do not influence catch. However, it is quite unlikely that additional time spent fishing is not rewarded, on average, with more catch. Note that with the indicator variable d, we can also estimate catch for mode and species or for mode/species groups.

The Poisson is estimated on the number of fish caught per trip, a discrete variable. The Poisson process describes the frequency of an event per period of time. In the production process we model fish caught per trip, which is an integer. Catch rate is not an integer and cannot be modeled via a count process. The arrival of fish per trip is conditioned on the number of hours per trip, the historic catch rate at the site and the experience of the angler. The distribution of catch per trip naturally varies with the number of hours per trip. When an angler spends more time fishing, the arrival rate per trip ought to be higher but one may wonder if the arrival rate per hour would change. In fact, on average, the arrival rate per hour will not change with more hours fished if the inverse of the mean hours per trip is equal to a_1, that is:

(17) $a_1 = 1/\underline{HRSF}$

where $\underline{HRSF}$ is the mean hours fished.[10] If the coefficient deviates much from the inverse of this mean, then the hourly success rate will be a function of the number of hours fished. When the Poisson is estimated as a function of the log(HRFS) then a test of

[10] This result can be seen by setting the derivative of Q/H with respect to H equal to zero.

success rate being constant as a function of hours is simply that $a_1=1$.

Given the Poisson model of catching fish, we can now examine more precisely how the random utility model works. Define the quality variable $q_{jmk}=Q_{jmk}/HRFS_k$ as the catch rate at site j, mode/species m for angler k. Bearing in mind that the model depends in a substantive way on individual characteristics, we can drop the k subscript and demonstrate the workings of the model. With the quality variable defined as q_{im}, we can write the utility from mode/species k, site j as

$$(18) \quad u_{jm} = \beta(c_j+c_m) + \gamma q_{jm} + \varepsilon_{jm}$$

Then the probability of choosing site j, given mode/species m is:

$$(19) \quad \text{Prob}(j|m)=\exp[(\beta c_j +\gamma q_{jm})/\theta]/\Sigma\exp[(\beta c_h +\gamma q_{hm})/\theta].$$

At this stage, we would estimate parameters for the site choice conditioned on the mode/species choice, and recover β/θ and γ/θ. Then we estimate the parameters for the mode/species choice. Note that the only parameter not recovered is θ. The mode/species probability is

$$(20) \quad \text{Prob}(m) = \exp(\beta c_m + \theta I_m)/\Sigma\exp(\beta c_n + \theta I_n)$$

where I_m is the inclusive value for mode m, defined as $I_m = \ln(\Sigma\exp[(\beta c_h +\gamma q_{hm})/\theta])$. With this probability we can estimate the parameter θ, and then recover β and γ.

Welfare Calculations

The goal of the empirical research is the calculation of the willingness to pay for improvements or declines in fishing circumstances, especially those that can be influenced by fisheries policy or changes in the marine environment. The basic insight for calculating welfare changes is that preferences for individual anglers are deterministic to the angler but not fully observed by researchers. Researchers take expectations of the best that the individuals can do.

Suppose that the utility function is given by

$$(21) \quad u_{jm} = \beta(c_j+c_m) + \gamma q_{jm} + \varepsilon_{jm,}$$

as analyzed above. The individual's willingness to pay (WTP) will be based on the indirect utility. This will be the expected value of the maximum utility for the angler:

$$(22) \quad V(c,q) = E\max_{(j,m)}\{[\beta(c_j+c_m) + \gamma q_{jm} + \varepsilon_{jm}]\ j=1,J;m=1,M\}$$

$$= \log\{\Sigma_n[\Sigma_h(\beta(c_h+c_m) + \gamma q_{hm})/\theta]^\theta\}.$$

From this we can calculate the WTp for changes in the c vectorCthat is costs, or changes in the determinants of qCthe catch and keep rates. From the previous development of the Poisson, recall that q is determined by mode/species, season, the angler's experience, and the historical catch and keep rate, among other things. Hence any of these determinants can be changed exogenously. The elimination of a site is equivalent to letting its price go to infinity. Suppose that c^1, q^1 represent the new sets of exogenous variables and c^0, q^0 the original set. Then the WTP for this set of changes equals:

(23) $\mathrm{WTP} = [V(c^1,q^1)\ \mathrm{B}\ V(c^0,q^0)]/\beta$

where V(c,q) can be calculated from the expression above. Note that the welfare calculation depends on the parameter of the distribution of $\varepsilon_{jm,}$ because this reflects the researcher's assumption about the unobservable portion of the angler's preferences.

Chapter 3
The MRFSS-AMES Data

The data used for this study are from the National Marine Fisheries Service's Marine Recreational Fishery Statistics Survey (MRFSS) in the Southeastern (SE) United States. The MRFSS consists of two parts, an intercept survey and a telephone survey. We use data from the intercept survey that gathers catch and demographic information. Sampling is stratified by state, mode (party/charter boat, private/rental boat, shore), and wave and allocated according to fishing pressure. Sampling sites are randomly selected from an updated list of access sites. Over 57,000 intercept interviews of recreational anglers were conducted at over 1,000 fishing sites from North Carolina to Louisiana in 1997.

The NMFS also conducts a telephone survey of coastal residents to determine marine recreational fishing participation. Catch and effort estimates are made using the MRFSS telephone and intercept surveys, combined with Census and historical data (National Marine Fisheries Service, 1999). We use the unweighted SE MRFSS data, not correcting for stratification. The MRFSS data is also prone to avidity bias where the probability of being interviewed increases with the number of fishing trips (Thomson, 1991). We do not correct for avidity bias. Therefore, our models are not necessarily representative of the population.

During 1997 approximately 10,000 Add-On MRFSS Economic Survey (AMES) telephone interviews were conducted with MRFSS intercept respondents who agreed to be interviewed (QuanTech, 1998). The interviews consist of Wave 2 through Wave 6 (March 1997 through December 1997) intercepted anglers. The 12-month survey was completed in 1998 with Wave 1 (January 1998 and February 1998) for Florida through Louisiana.[11] Wave 1 AMES interviews are not included in our analysis due to their unavailability at the time of this study. The AMES collected detailed information about the expenditures for the intercepted trip and wave-level trips. Combining the MRFSS and AMES data and omitting observations with missing data on key variables results in 8865 useable cases.

Data Description

A majority of the 8865 interviewed anglers (60%) fish from either a private or a rental boat (Table 3-1). Approximately 30% fish from the shore with the remaining 10% fishing from a party or charter boat. The method of fishing is referred to as the mode. In addition to the mode of fishing, the MRFSS contains information on the specific species targeted on the current trip. We aggregate species into five groups following Hicks, et al.,

[11] Wave 1 interviews are not collected in Georgia, North Carolina, and South Carolina.

(1999).[12] Of the reported target species, 32% of anglers target one of thirty-seven small game species such as red drum (Table 3-2). Five percent, 7%, and 3% of the anglers target big game (e.g., cobia), bottom fish (e.g., grouper), and flat fish (e.g., flounder) species. Over 50% of Southeast anglers do not target species (e.g., Afishing for whatever is biting@) or other target species (e.g., eel).[13]

Cross tabulations of mode and species choice indicate that private/rental boat anglers who target small game (24%) or other species (26%) are most common in these data (Table 3-3). Other combinations of mode/species choice are big game (3.8%), bottom fish (4%), and flat fish (2.3%) anglers who fish from private/rental boats, small game (6.2%) and bottom fish (2.3%) shore anglers. The other species/mode choices include less than 200 anglers. No one in the sample targets flat fish from a party/charter boat. Only 22 anglers target big game fish from the shore.

For tractability, the National Marine Fisheries Service intercept sites are aggregated into seventy-seven county level fishing zones (Table 3-4).[14] Seven of these zones are not represented in the AMES. The seventy zone choice pattern serves as the dependent variable in the site-selection random utility models. Less than 5% of the anglers interviewed were intercepted in Alabama, Georgia, and Mississippi. Over 50% of the anglers interviewed were intercepted in Florida. Eleven, 17, and 8 percent were intercepted in Louisiana, North Carolina, and South Carolina.

Zones with more than two hundred interviews include Brevard, Hillsborough, Monroe, Palm Beach, Pasco, and Pinellas Counties in Florida. Pinellas County alone accounted for 7% of the sample. Two hundred sixty-five anglers fished in Plaquemines County in Louisiana. Four hundred forty-seven and 978 anglers fished in Carteret and Dare Counties in North Carolina. In South Carolina, 222 and 248 anglers were intercepted in Georgetown and Horry Counties. The most popular site in Alabama is Baldwin County (n=185). The most popular site in Georgia is Chatham County (n=163).

Data Summary

In this section we present a summary of angler characteristics broken down by region (South Atlantic, Gulf of Mexico) of intercept (Tables 3-5 and 3-6).[15] For this data comparison we use incomplete case analysis so that the extent of item nonresponse can

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[12] See Appendix A for a list of each species in these groups.

[13] The number of anglers not included in the four species groups is more than twice the number found by Hicks, et al., (1999) using comparable data for the Northeastern U.S. While this large difference deserves some attention, it is beyond the scope of this project.

[14] See Appendix A for the SAS zone codes.

[15] A series of data summary tables broken down by state, mode, species, wave, and state by wave is also available from the authors.

be assessed. Of the 9384 anglers in the AMES data, a little less than one-half was intercepted on the South Atlantic coast (4330). Slightly more than one-half of these anglers were intercepted on the Gulf of Mexico coast (5054).

<u>South Atlantic Anglers</u>

Demographic data was collected during the AMES telephone follow up interview. The average income of these anglers was $54,080 (HH_INCOM). Only 66% percent of respondents revealed their household income. Seventy-six percent of the anglers were employed (EMPLOYED) and 91% are white (WHITE). The average age was about 45 years (AGE2). The average number of years of fishing experience was 22 (YRSFISH). Seventeen of these years were spent fishing in the state of the intercept (YRFISHST).

Detailed trip information was also collected in the AMES telephone interview. Each angler fished an average of 7 days during the 2-month wave (TRIPS). Almost 6 of these days were spent fishing from the same mode (MODE_TRP). Almost 5 of these days were spent fishing for the same target species (MODE_TAR). Each angler took an average of 4.47 fishing trips from the intercepted site during the 2-month wave (VISIT). Almost all (4.32) of these trips were spent fishing from the same mode (VIS_MODE). About three and two-thirds of these trips were spent fishing for the same target species (VIS_TAR).

As suggested by a comparison of the number of days spent fishing and the number of trips taken, an average of .79 of these trips were overnight trips (OVTRIP). The average number of nights away from home was 2.27 (TRIP_DAY). In percentage terms, 33% of the trips were multi-day trips (MULTI). The average number of fishing days on these trips was 1.6 (FISH_DAY). Two additional measures of trips from the MRFSS intercept data are reported at the bottom of the table. The number of fishing days during the two-month wave was a little more than 7 (FFDAYS2) and the number of fishing days during the past year was almost 36 (FFDAYS12).

Fifty-five percent of Atlantic coast anglers own their own boat (BOATOWN). For those who were taking a boat trip, the average party size was 2.87 (PARTY). The average number of hours fished on the trip was 4.43 (HRSF). This information is collected during the MRFSS intercept interview.

Trip expenditure data was also collected from anglers in the intercept interview. The average lodging expenditures was $78 (LODGEXP). The average travel expense was $49 (TRAVEXP). Other trip expenses (e.g. bait) totaled $25. The average amount of time traveled from home to lodging was 135 minutes (TIMETRAV). The amount of time traveled from the place of lodging to the site was about 49 minutes (TIMESITE).

<u>Gulf Coast Anglers</u>

For the Gulf Coast anglers the average income was slightly lower at $52.990.

Only 64% percent of Gulf Coast respondents revealed their household income. Seventy-seven percent of the anglers were employed and 91% are white. The average age was about 44 years. The average number of years of fishing experience was 21 with 17 of these years spent fishing in the state of the intercept.

In general, Gulf Coast anglers fished slightly less than Atlantic Coast anglers. Each angler fished an average of less than 7 days during the 2-month wave. About 5 of these days were spent fishing from the same mode. About 4 and one-half of these days were spent fishing for the same target species. Each angler took an average of 4.15 fishing trips during the 2-month wave. Again, almost all (4.07) of these trips were spent fishing from the same mode. Almost three and one-half of these trips were spent fishing for the same target species.

Gulf Coast anglers spend fewer nights away from home fishing. An average of .56 of these trips were overnight trips. The average number of nights away from home was almost 2 days. Only 23% of the trips were multi-day trips. The average number of fishing days on these trips was about one (1.05). The pattern of trips from the MRFSS intercept data is similar. The number of fishing days during the two-month wave was 6.7 (FFDAYS2). Gulf Coast anglers spent about two more days fishing during the past year than Atlantic Coast anglers (38).

Slightly more Gulf coast anglers own their own boat (60%). For those who were taking a boat trip, the average party size was almost 3. The average number of hours fished on the trip was 4.36.

Trip expenditures are lower for Gulf Coast trips. The average lodging expenditures were only $59. The average travel expense was $33. Other trip expenses totaled $21. The average amount of time traveled from home to lodging was 81 minutes. The amount of time traveled from the place of lodging to the site was 50 minutes.

Travel and Time Costs

Distances from the household zip code to each county zone zip code are calculated using PC*Miler. The average one-way distance to the zone visited is 159 miles.
[16] Travel and time costs are measured as in Hicks, et al., (1999).
[17] Travel costs are calculated at $.30 per mile traveled and time costs are calculated

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[16] The median one-way distance to the zone is 49 miles.
[17] Self-reported trip expenditures could also be used in recreation demand modeling. We find that trip expenditures and distance are linearly related in a regression model with trip expenditures as the dependent variable and the round trip distance to the site (measured by PC*Miler) as the independent variable. In this model, there is a fixed travel expense of $10.38 and a per-mile expense of $.095 ($R^2$ = .09).

using estimated travel times (assuming 40 mph). The household wage rate is used as the opportunity cost of travel time. Only those respondents who reported that they lost income during the trip are assigned a time cost in the trip cost variable. This is measured with the LOSEINC variable from the AMES. The trip cost variable is

$$\text{Trip Cost} = \begin{cases} \$.30*D + \text{wage}*(D/40) & \text{if LOSEINC} = 1 \\ \$.30*D & \text{otherwise} \end{cases}$$

where D is the round trip distance. The wage is measured as household income (in thousands) divided by 2.08 (the number of fulltime hours potentially worked annually in thousands). For those respondents who do not lose income, the time cost is accounted for with an additional variable equal to the amount of time spent in travel. This is estimated as the round trip distance divided by 40 mph

$$\text{Time Cost} = \begin{cases} D/40 & \text{if LOSEINC} = 0 \\ 0 & \text{otherwise} \end{cases}$$

Household wage rates are estimated for the large portion of respondents who did not report income.
[18] A log-linear ordinary least squares regression model is used to impute missing income values. The resulting income imputation equation is:

$$(24)\quad \ln(HHINC) = -.64 + .28*WHITE + .07*MALE + .11*AGE - .0018*AGE^2$$

$$+ .0000087*AGE^3 + .45*EMPLOYED + .15*BOATOWN + .81*\ln(STINC),$$

where HHINC is the reported household income, WHITE=1 if the respondent reports being white, MALE=1 for males, AGE=age in years, EMPLOYED=1 if the respondent is currently employed, BOATOWN=1 if the respondent owns a boat, and STINC is the average income of residents in the respondent's home state. Each of the independent variables is statistically significant at the .01 level. The R^2 for the model is .16.

The average imputed household income is almost $52,000. The household wage is equal to the household income divided by 2080 hours. The average household wage is $23.66. The average travel and time cost to the visited zone is $282.[19]

Household Production Models

In Chapter 2 we motivated the random utility model as a means of choice in

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[18] The MRFSS contains others measures of income that are theoretically preferred such as the hourly wage rate and personal income. However, the sample sizes for these variables contain about 67% more missing data than that for household income.
[19] The median travel and time cost is $67.

which the angler decides among alternatives based on their measurable attributes. For recreational fishing, the catch is a critically important attribute, both from the perspective of how anglers choose, and for the influence of fisheries policy. The catch variable in a random utility model is typically the means by which fisheries policy impacts anglers.

We consider four potential measures of fishing quality: historic catch, historic catch and keep, predicted targeted catch and predicted targeted catch and keep. Targeted catch refers to those fish caught (and kept) that were targeted by the angler. Incidental catch is not included in these measures. Models of expected catch have the advantage of facilitating analysis of policy measures such as bag limits that influence the distribution of fish caught and kept (harvest). This analysis is not feasible with historic catch and keep.

Five year historic targeted catch and keep rates were calculated from the 1991-1996 MRFSS for four of the five species groups (big game, small game, flat fish and bottom fish). The catch of the targeted species groups were aggregated at the county level. The five-year average historic targeted catch and keep rates are used as independent variables in the catch and keep rate household production models.

Targeted catch and keep rate variables include only catch and keep of the fish targeted. For example, the catch (and keep/harvest) rates that we consider are bottom fish catch and harvest by bottom fish anglers. We do not include incidental catch in these catch rates.[20] Following, Hicks, et al. (1999) the Aother@ category includes anglers who target other species and also anglers who do not target fish. The catch of Aother@ species by anglers who do not target fish is included in the measure of catch for the OTHER anglers.[21]

We considered several potential functional forms and specifications for the household production models. Household production models for individual species groups do not perform particularly well, especially for the flat, bottom, and big game species (Wang, 1999). We also conducted numerous specification tests to determine the best combination of variables in the household production models. For example, a specific measure of fishing experience, visits to the site/mode/species during the past 2 months (VIS_TAR), only marginally helped explain the actual catch and keep (Wang, 1999). Li (1999) determined that there is considerable noise in the catch rate data, relative to the catch and keep rate data, leading to measurement error problems in the

[20] Incidental catch is another potentially important independent variable in the random utility model. However, due to time constraints, it is not pursued in this report. We leave this for future research.
[21] The appropriate way of measuring fishing quality through catch rates for those who do not target fish in the MRFSS is unclear. The approach we have taken is only one alternative. For the OTHER anglers, interpretation of the values of catch rates in chapter 6 should be interpreted with caution.

household production mdoels. Li (1999) also determined that that pooled catch and keep models, without including interactions among waves and species, perform best.

Based on these pretests of the household production models, we consider only pooled models with catch and keep as the dependent variable in the rest of this chapter.[22] Poisson and negative binomial models are used to estimate expected catch rates at each site for the relevant species for each angler by mode (McConnell, Strand, and Blake-Hedges, 1999; Smith, Liu, and Palmquist, 1993). The negative binomial model represents a generalization of the standard Poisson model and relaxes the restrictive equal mean/variance assumption of the Poisson. If overdispersion is present in the reported catch rates (unequal mean and variance) then the Poisson model will be misspecified and result in inefficient predictions of expected catch rates.

In our preliminary attempts at modeling catch and keep rates we found that in both the Poisson and negative binomial models individual catch and keep rates increase with the historic catch and keep rate at the site and the number of hours fished (Haab and Whitehead, 1999). Fishing experience increases harvest rates at a decreasing rate. Fewer fish are kept on private/rental boat and shore trips relative to party/charter trips. More fish are caught during waves 3, 4, 5, and 6 relative to wave 2. In the negative binomial models the scale parameter (alpha) is statistically significant indicating that there is overdispersion in the data. In preliminary models we attempted to test for the endogeneity of hours fished using an instrumental variable. We are unable to explain more than 1-2% of the variation in hours fished so we abandoned our efforts.

Predicted harvest is calculated using equation (9) from McConnell, Strand and Blake-Hedges (1995, p.253). Actual catch and keep and the predicted keep rates for the five species groups predicted from the Poisson and negative binomial (PRED_NB) models appears in Haab and Whitehead (1999). The negative binomial models perform better in terms of predicting the range of the observed keep rates. However, these models overstate the average catch by between 32% and 49% for big game, small game, bottom fish and flat fish. In order to solve this problem we adopt the Poisson model with an overdispersion correction to predict catch rates (Cameron and Trivedi, 1986).

Based on the results of this preliminary research we focus our attention on the Poisson model with an overdispersion correction that includes historic catch and keep rates (HCKR), hours fished (HRSF), number of years fished in the state of intercept (YRFISHST) and its square, and mode, wave, and species target dummy variables: big game (BIG), small game (SMALL), bottom fish (BOTTOM), flat fish (FLAT). The other/non-targeted fish (OTHER) is the excluded category.

We estimate the household production model for day-trippers only as in Hicks, et

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[22] See Haab and Whitehead (1999) for a comparison of the catch and catch and keep measures of quality in RUM models.

al. (1999). The dependent variable is the number of fish caught and kept per trip (Table 3-7). In practice, the dependent (Y) and independent variables (X) are entered in levels. However, the functional form of the Poisson model is log-linear: $\ln Y = a + BX$. The marginal effect of the independent variables on the dependent variable is not equal to the variable coefficient (B) as in a linear model. The marginal effect is non-linear and a function of the independent variables: $dY/dX = B*\exp(a + BX)$. At the mean of the dependent variable, the marginal effect is $B*Y$.

Anglers who target big game, small game, bottom fish, and flat fish catch more than anglers who do not target fish. More fish are caught during May and June (WAVE3), July and August (WAVE4), September and October (WAVE5), and November and December (WAVE6) relative to March and April (WAVE2 is the excluded variable). Fewer fish are kept on private/rental boat (MODE2) and shore trips (MODE3) relative to party/charter trips (MODE1 is the excluded variable).

Harvest rates increase with the average targeted historic catch and keep rate at the site (HCKR). The marginal effect of HCKR on the actual catch and keep is 0.095. This indicates that for each one unit increase in the historic catch and keep rate, the actual catch and keep rate increases by about .095 unit (fish). With a positive coefficient on historic catch and keep, the marginal effect is increasing in historic catch and keep. For example, the marginal effect of a site with a relatively high historic catch and keep rate will be higher than the marginal effect of a site with a relatively low historic rate.

The remainder of the variation in catch and keep rates is due to time spent fishing and individual technology. Actual catch and keep rates increase with the number of hours fished (HRSF). The inverse of the mean HRSF is more than twice the coefficient on HRSF. This result indicates that the hourly catch and keep rate is decreasing in the number of hours fished. For these anglers, patience does not pay off. Fishing experience, measured by the number of years fished in the state of the interview, increases catch and keep rates (at a diminishing rate). Boat ownership does not increase the number of fish caught and kept.

The quality variables in the alternative site-selection random utility models are the mean historic and predicted catch and keep rates. The predicted harvest rates are measured with the specific variables for each angler. For example, the individual specific dummy variables for wave and mode and the historic catch and keep rate at each site are used to predict catch and keep rates for each angler at each site. Therefore, each quality measure is specific to the mode and wave for which the individual fished.

Chapter 4
Distance and Catch Based Choice Sets

The basic approach of the report is the estimation of a site choice model. In modeling the choice among sites, the researcher may choose the set of alternatives deemed suitable for each angler. Careful construction of site choice sets is important for practical and conceptual reasons. Reducing the number of site choices makes the logistics of setting up a random utility model more manageable. For example using five sites rather than the full set of 70 is a great savings of space and time. And conceptually, it does not seem likely that each angler fully considers all 70 sites, regardless of where the angler lives.

Recent literature has blossomed with attempts to narrow the set of alternatives (the choice set) assumed available to the recreator. Parsons and Hauber (1998) have shown that the number of zones to be considered by each angler can be limited geographically. Beyond a distance threshold, consideration of additional zones has little impact on welfare measures. Haab and Hicks (1998) and Hicks and Strand (1998) have shown that further narrowing of the choice set based on a combination of individual and zone-specific attributes can improve the accuracy of welfare estimates. However, the welfare estimates are often sensitive to the definition of the choice set.

In this chapter we consider the effect of alternative distance and quality based choice sets on welfare measures. Various definitions for the geographic extent of the market are used to determine the effect of distance based choice set definitions on random utility model parameter estimates and welfare estimates. Quality based choice sets are defined using two different zone quality measures: five-year average historic harvest rates at a zone and individual specific predicted harvest rates at each zone. The welfare effects of distance and quality based choice sets are considered independently and jointly.

In this chapter we focus on the effects of choice set definition and avoid complications introduced by nesting structure and modeling assumptions in more complete models of SE recreational site choice. Therefore we conduct our comparisons with the small game target and private/rental boat mode -- the most popular species-mode choice in the MRFSS-AMES data (n=1914).

Choice Sets

To examine the effects of choice set definition, ten choice sets based on distance and historic catch and keep rates were constructed. Table 4-1 enumerates the choice sets. The first choice set includes the full set of potential fishing zones (all 70 county zones). The second through fifth choice sets reduce the set of alternative zones available to the recreator based on distance. The second choice set includes the actual zone chosen and eliminates any zone beyond 360 miles of the one-way travel distance. If this choice set only contains one zone, then the closest zone to the angler's residence is also included. If the closest zone is the actual zone chosen then the next closest zone is included. The third through fifth choice set reduces the maximum travel distance allowed by 60-mile increments. So, for choice set 5 only zones within 180 miles are considered.

The sixth, seventh, and eighth choice sets are based on average historic targeted catch and keep rates. The sixth choice set eliminates all zones for which the average historic harvest rate is less than .25 fish. The seventh and eighth choice set eliminates all zones for which the average harvest rate is less than .33 and .50 fish.

The ninth and tenth choice sets combine distance and quality criteria. The ninth choice set excludes zones beyond 300 miles and with average catch and keep less than .25 fish. The tenth choice set excludes zones beyond 180 miles and with average catch and keep less than .25 fish.

Given the definitions in Table 4-1, anglers are assumed to consider an average of almost 28 zones in the second choice set. The minimum number of zones considered by an angler are 2 and the maximum are 43. The average number of zones in the third through fifth choice sets is 24, 19, and 13.5. The harvest criteria eliminate fewer zones than the distance based choice sets. The average number of zones for choice sets six, seven, and eight are 61, 57.5, and 52. The range of zones considered in the catch-based choice sets is also narrower than the distance based choice sets. The minimum number of zones in these choice sets is 55, 53, and 45. In the combined distance and catch based choice sets the average number of zones included is 21 and 12 for choice sets nine and ten.

Site Selection Models

Some characteristics of the sample are presented in Table 4-2. Most of the trips are to the Gulf Coast of Florida (43%), Louisiana (22%) and the Atlantic Coast of Florida (15%). The average number of trips across each two-month wave is 3.66. The average historic catch and keep rate at the chosen zone is 1.51. Predicted catch and keep for each angler at each zone is calculated using the Poisson catch and keep rate estimates described in Chapter 3. The predicted harvest rate at the chosen zone is 1.78 with much more variability across zones relative to the historic rate. The standard deviation of the predicted catch and keep rate is almost four times greater than for the historic catch and keep rate.

Conditional logit (non-nested) random utility site-choice models are estimated using both historic catch and keep and predicted catch and keep rates as zone quality measures. Table 4-3 presents the results from twenty site selection random utility models for small game-private/rental boat anglers. Prior expectations dictate the trip cost parameter to be negative and the zone quality parameter to be positive. All of the parameter estimates have the expected sign except one and all but three of the parameter estimates are statistically significant at the .10 level. The insignificant coefficients are for the historic catch and keep rate variable in choice sets six, seven, and eight. When the choice set is restricted by the historic rate, the lack of variability in quality for the zones remaining leads to insignificant effects of zone quality on zone choice. The most restrictive catch rate based choice set (eight) leads to a negative coefficient on quality.

The most striking result is that choice set definition has very little effect on the trip cost coefficients. Trip cost coefficients range from -.053 to -.057 even though the choice set definitions in Table 4-3 eliminate an average minimum of 13% and maximum of 82% of the available zones. The change in the trip cost parameter is largest (relative to the full-choice set) when the choice set is restricted to only zones with at least a .50 historic harvest rate. The quality coefficients for the predicted catch and keep rate models are always at least 2.5 times greater than for the historic catch and keep rate models. For distance based choice sets, the quality coefficients do not change in magnitude. When the distance-based choice sets are narrowed by catch rates (sets 9 and 10) the effect of quality on site selection is smaller.

We find more variability in the quality coefficients across choice set when using the predicted harvest rate variable. Again, however, the distance based choice sets have little effect on the quality coefficients. When the number of zones in the choice set are restricted based on historic harvest rates the size of the quality coefficient falls by about 20%, 25%, and almost 50% when comparing sets six, seven, and eight to the base case (choice set 1). When eliminating some zones from the catch based choice sets combined with distance thresholds (choice sets 9 and 10) the coefficients on zone quality fall between the strictly distance based and catch based choice sets quality coefficients.

Other RUM results are presented in Haab and Whitehead (1999) for other SE MRFSS species/mode combinations that contained more than 200 cases. For all species models the trip cost coefficients are similar when comparing similar distance based choice sets. For private/rental boat trips, neither of the quality coefficients are statistically significant for big game anglers and both of the quality coefficients are significant for bottom fish anglers. In contrast to small game, the coefficient on the mean historic catch and keep rate variable is much larger than the coefficient on the predicted catch and keep rate variable for bottom fish anglers. For flat fish anglers, only the historic harvest quality coefficient is significant. For shore anglers, none of the quality coefficients are significantly different from zero.

Welfare Measures

The welfare measures are calculated from the expected compensating variation of a loss of access to zones aggregated at the state/region level and for an increase in expected catch using the Aquick@ formulas in the appendix to this chapter. Table 4-4 presents the minimum, median, and maximum welfare measures for loss of access to each state across the ten choice sets for both measures of zone quality. We find very little difference in these welfare measures indicating that our selection of choice sets does not affect the value of zone access. We find large differences in the value of a trip across states. For example, the lost compensating variation of a trip if access to the Gulf Coast of Florida is eliminated is about $8 but the value of a trip to Alabama is less than $1. These differences are driven by zone selection patterns and not the model estimates. They are quite reasonable, given that substitution to other sites is so much easier when the Alabama sites are eliminated than when the Florida sites are eliminated. We find virtually no difference in the value of zone access across the two measures of site quality.

The compensating variation per trip estimates are multiplied by the average number of trips taken during the 2 month wave targeting small game, and using private/rental boats (Table 4-5). This provides an estimate of the value of access over the 2 month time period. The pattern of results is similar as in Table 4-4. The Gulf coast of Florida is the most valuable fishing zone for small game boat anglers. Louisiana and the Atlantic coast of Florida have values of about $12 per wave.

In Table 4-6 we present the compensating variation per trip of an increase in the catch and keep rate by one additional fish using the Aquick@ welfare measures from the appendix. The value of an additional fish does not vary across distance based choice sets. The value of an additional fish is smaller when the choice set is limited by historic catch and keep rates, although this effect is slight when using the predicted catch and keep rate as the measure of quality. The value of an additional fish is more than twice as large when using the predicted catch and keep rate as the measure of quality.

Discussion

In this chapter we find that choice sets based on distance do not lead to large differences in angler welfare. Our distance thresholds, approximately 3 to 6 hour one-way drives, may be beyond the realistic time constraints for day-tripping small game anglers. In this sense, our results support the findings of Parsons and Hauber (1998). Rejecting zones from the choice set that may be unrealistic substitutes does not affect the model. Of course, we are tempted to reject additional zones from the choice set based on a further tightening of the distance threshold to determine at what threshold differences in welfare measures arise. However, our most restrictive choice set includes an average of only 13.5 zones so further narrowing of the choice set may not represent angler behavior well.

Defining choice sets based on minimum historic catch and keep rates does not lead to large effects on the trip cost parameter estimates or per trip welfare measures. We do find, however, that the RUM parameter estimate for fishing quality is affected. When the historic catch and keep rate is used as the measure of fishing quality, the parameter estimate is insignificant and zone quality does not seem to matter to anglers. When the predicted catch and keep rate is the measure of zone quality the effect of zone quality on zone selection is smaller. When combining a distance threshold to the quality based choice sets we find results that are closer to the base case model. Both measures of zone quality are significant predictors of zone selection but their effects are smaller in comparison to the baseline model.

We find differences in RUM parameter estimates on quality and the welfare measure of an additional fish when comparing alternative measures of quality. The historic catch and keep rate is best considered as a proxy for the stock of fish at the zone. Increases in the stock of fish at the zone will potentially lead to increased catch and keep rates. The predicted catch and keep rate varies according to the historic catch and keep rate and individual characteristics that measure the anglers' ability to catch fish. The predicted catch and keep rate measure is the conceptually preferred measure of zone quality. This application suggests that using the historic catch and keep rate as the measure of zone quality would lead to under-estimates of the value of catching fish. We find a different result in the next chapter.

Appendix: Quick Welfare Estimates

In this Appendix we describe measures of welfare for site access and quality that can be estimated quickly and accurately from sample proportions and RUM parameter estimates. Following the standard derivation of the conditional-logit RUM (see Chapter 2), we assume that the individual will choose to visit the site that provides the maximum utility of all the available alternatives. Because this utility ranking is known to the recreator but unobservable to the researcher, the choice between alternatives can be viewed as random. Given an individual (i) and site specific (j) indirect utility function (v_{ij}) that is additively separable in a Type-I extreme value distributed random error term (ε_{ij}): $V_{ij}=v_{ij}+\varepsilon_{ij}$, the conditional logit model emerges such that the probability of individual i selecting site j (P_{ij}) becomes:

$$P_{ij} = \frac{e^{v_{ij}}}{\sum_j e^{v_{ij}}} \tag{25}$$

For our purposes, the indirect utility function is assumed to be a linear function of the individual and site-specific travel cost to each site (c_{ij}), and the associated expected catch and keep rate variable (q_{ij}):

$$v_{ij}=\beta_c c_{ij}+\beta_q q_{ij}, \tag{26}$$

where β_c is the negative of the marginal utility of income, and β_q is the parameter on expected catch.

An upper bound on compensating variation is calculated from the expected compensating variation of a loss of site access to site k from the conditional logit model equations (1) and (2) (See McConnell, Bockstael and Strand):

$$C_{ik} = \frac{\ln\left[\sum_j e^{v_{ij}}\right] - \ln\left[\sum_{j\neq k} e^{v_{ij}}\right]}{\beta_c}. \tag{27}$$

Rearranging, the compensating variation of the loss of site k can be written as:

$$C_{ik} = \frac{-\ln\left[1 - P_{ik}\right]}{\beta_c}, \tag{28}$$

where P_{ik} is defined in equation (25). As P_{ik} approaches zero, $-\ln[1-P_{ik}]$ approaches P_{ik}. For larger P_{ik}, $-\ln[1-P_{ik}]>P_{ik}$ and as such P_{ik} serves as a lower bound. Substituting into

(28), and recognizing β_c<0, that we find that:

$$(29)\qquad C_{ik} \leq \frac{P_{ik}}{\beta_c}.$$

For the population, the average compensating variation of loss of site access to k (summing (29) over the population and dividing by N) is bound from above by:

$$(30)\qquad \overline{C}_k \leq \frac{\overline{P}_k}{\beta_c}.$$

$\overline{P}_k$ represents the population mean probability of visiting site k. As such, $\overline{P}_k$ can be consistently estimated using the observed sample frequency of visits to site k. In other words, the upper bound welfare loss due to elimination of a site described in (30) can be consistently estimated by dividing the observed sample frequency of visits to a site by the negative of the estimate of the marginal utility of income. A couple of caveats must be noted. The larger the frequency of visits to a site, the larger the divergence between the upper bound estimate in (30) and the actual expected welfare loss. Further, the welfare measure in (30) relies on the indirect utility function being additively linear in income. Despite these caveats, the lower bound welfare measure in (30) provides a quick (and for large site selection models, accurate) measure of the expected welfare loss of site elimination.

In addition to the welfare approximation for loss of site access presented above, a simple measure of welfare for an increase in expected catch (or quality) exists. Suppose instead of looking at percentage increases and decreases in the expected catch at all sites (as appears to be the standard policy measure in the literature) we instead look at the welfare effect of an absolute increase in catch at all sites. For simplicity we will assume that the measure of interest is an increase in expected catch of one fish at every site. For the linear conditional logit model, the welfare change of a one fish expected catch increase at all sites is:

$$(31)\qquad C_{i(+1)} = \frac{\ln\left[\sum_j e^{\beta_c c_{ij} + \beta_q q_{ij}}\right] - \ln\left[\sum_j e^{\beta_c c_{ij} + \beta_q (q_{ij}+1)}\right]}{\beta_c}$$

Upon simplification, (31) becomes:

$$(32)\qquad \overline{C}_{i(+1)} \leq \frac{-\beta_q}{\beta_c}.$$

By simply dividing the catch coefficient by the marginal utility of income, we get an estimate of the welfare gain from an increase in expected catch of one fish. While a one fish increase at every site is biologically infeasible for most species, scaling down the increase in expected catch by a constant (e.g. .01 additional fish at every site) or aggregating only over the affected population provides a quick and simple measure of welfare from the conditional logit model. The welfare measure in (32) can simply be multiplied by the expected increase in fish catch over the population to find the population welfare gain.

Chapter 5
Red Drum, Spotted Seatrout, Coastal Migratory Pelagic and Snapper-Grouper Models

The purpose of this chapter is to examine the feasibility of using the MRFSS-AMES data for individual species of special interest in the South Atlantic and Gulf of Mexico. These species, king and Spanish mackerel, red drum, spotted seatrout, red snapper, and red grouper, are potentially the focus of management initiatives and appear to have greater economic prominence than other species. This modeling experiment involves a different set of choices for anglers, and exploits a subset of the full AMES sample.

Among the six species of special interest, only two, spotted seatrout and red drum, have sufficient observations to permit random utility modeling. Of the 52% (=4808/9201) of AMES anglers who report targeting these specific fish 21% target spotted seatrout and 19% target red drum. These two species are by far the most popular fish in the AMES data. The other four speciesCking and Spanish mackerel, red snapper and red grouperCdid not produce enough observations to enable random utility modeling. They are bundled into two aggregate species groups.[23] The two species groups are coastal migratory pelagic fish (including king and Spanish mackerel) and snapper-grouper fish (including red snapper and red grouper). Consequently, the anglers will choose among four species alternatives: red drum, spotted seatrout, coastal migratory pelagic, and snapper-grouper fish.

The random utility models for these choices are estimated on a subset of the sample of anglersCthose who fish from the private/rental boat mode. About 75%-87% of all anglers who target red drum, spotted seatrout, coastal migratory pelagic, or snapper-grouper fish from the private/rental boat mode giving good coverage of targeting of these species. The sample is limited to these 2084 anglers, which represents 43% of the anglers in the AMES data who target fish.

Coastal migratory pelagic (hereafter, simply pelagic) fish include bluefish (Gulf of Mexico only), cero, cobia, dolphin, king mackerel, little tunny, and Spanish mackerel.[24] Of the private/rental boat anglers in the AMES data, none target bluefish or cero and only three target little tunny. Most of the 507 anglers in this group target king mackerel (185) or dolphin (153) while 92 and 74 anglers target cobia and Spanish mackerel, respectively. Five year (1992-1996) historic catch and keep rates were calculated from the MRFSS intercept data including each fish in the coastal migratory pelagic group regardless of whether it is targeted by anyone in the AMES data.[25]

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[23] These species groups were suggested by Stephen Holiman (NMFS-SERO).
[24] See Appendix A for the species in this group.
[25] Again, all historic catch rate variables are wave specific. For example, if an angler was intercepted during the May-June Wave 3, the historic catch rates they are assumed to

The snapper-grouper group includes seventy-two species of South Atlantic reef fish and forty-two species of Gulf of Mexico reef fish (see footnote 2). One-hundred eighty anglers target snapper-grouper fish using the private/rental boat mode. Almost 41% of these anglers target gag grouper and 23% target sheepshead. Other species in this group are red snapper (targeted by 11%), gray snapper (9%), red grouper (4%), black sea bass (4%), yellowtail snapper (2%), mutton snapper (2%), and crevalle jack (2%). A lone angler targeted cubera snapper, lane snapper, Atlantic spadefish and gray triggerfish. Five year (1992-1996) historic catch and keep rates were calculated from the MRFSS intercept data including each fish in the snapper-grouper group regardless of whether it is represented in the AMES data.

The nested logit model we estimate is illustrated in Figure 5-1. The sample is limited to private/rental boat anglers who target red drum, spotted seatrout, pelagic fish, or snapper-grouper. Anglers are assumed to choose one of the four species (s_n, n = 1, Y, 4) and then choose the zone to visit (z_j, j = 1, Y, 68).[26] Attempts to expand the model to other modes were unsuccessful. For example, in a model of the participation decision to target one of these four species, the estimate of the coefficient on the instrumental variable is outside the zero, one interval.

We first present a data summary broken down for the four species and the Poisson household production models for harvest. We then present two sets of models related to this choice structure. The first is the site selection model estimated independently for each group. This assumes that once the primary targeted species is chosen the other species are no longer considered substitutes. For each of these models we consider the full choice set including each of the 68 visited sites and a choice set restricted to 180 miles distance. We also consider the mean historic catch and keep rate and predicted catch and keep rates as the quality variables. The second set of models is the nested logit estimated with full and restricted choice sets. We only consider the mean catch and keep rate as the quality variable for these models.

Data

The distribution of red drum and spotted seatrout anglers across Waves 2-6 is fairly flat with lows of 16% of all anglers in Wave 2 (red drum) and Waves 4 and 6 (spotted seatrout) and highs of 26% in Wave 5 for red drum and 24% in Wave 5 for spotted seatrout. The distribution of pelagic and snapper-grouper fish is more variable across wave. Only 9% of pelagic fish anglers took their trip during Wave 6 and only 9% of snapper-grouper anglers took their trip during Wave 2. Thirty-four percent of both pelagic and snapper-grouper anglers took their trip during Wave 2.

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consider when choosing their species and site are the Wave 3 catch rates.

[26] Two of the 70 zones are not visited with this sample.

The rest of the data is summarized in Table 5-1. The number of fish caught and kept by each angler is HARVEST. The harvest rate is highest for anglers who target spotted seatrout who catch and keep on average 2.32 fish per trip. Anglers who target snapper-grouper catch and keep 2.01 fish per trip. Anglers who target coastal migratory pelagic fish catch and keep 1.12 fish per trip. Anglers who target red drum catch and keep the least -- only .71 fish per trip. The red drum harvest rate is almost identical to the 5-year average historic targeted catch and keep rate at the zone visited (HCKR). For the other species, spotted seatrout anglers catch and keep almost .5 more fish and coastal migratory pelagic and snapper-grouper anglers catch and keep more than four times more fish than historically.[27]

Anglers are very similar on the other characteristics. About four-fifths of all boat anglers own their boat (BOATOWN). The average number of years spent fishing in the state of the intercept (YRFISHST) is between 19 and 21 years for each species. Anglers spent an average of a little more than 4.5 hours fishing (HRSF). The average number of marine recreational fishing trips during the most recent two-month period (TRIPS) is between 6.77 and 7.71. The average number of private/rental boat mode trips targeting the same species during the most recent two-month period (VIS_TAR) is between 3.07 and 3.53. The average one-way distance traveled to the visited site (DISTANCE) ranges from a low of 37 miles for snapper-grouper anglers to 51 miles for red drum anglers. Spotted seatrout, red drum and snapper angler households earn between \$47 and \$50 thousand dollars annually. Pelagic angler households earn \$56 thousand annually. The average age of anglers is between 42 and 46 years.

Household Production Models

The Poisson (with the overdispersion correction) household production (of catch and keep) models are presented in Table 5-2. Since a focus of this chapter is the consideration of individual species models, we estimate individual household production models for each species. In the Poisson, the probability of catching Y fish is given by

(33) $\text{Prob}(Y) = e^{Y}Y^{\lambda}/Y!$ for Y = 0, 1, 2,Y.

The probabilty is conditioned on the historic catch and keep rate, wave indicator variables, and individual characteristics, through the conditional mean:

[27]From these comparisons, it appears that anglers in the AMES data are more skilled at catching fish than anglers in the general MRFSS sample. However, for sites that were not visited during any wave, the imputed catch rate is zero. This decision will reduce the historic catch and keep rate estimates. McConnell and Strand imputed missing values from neighboring sites when possible. Hicks, et al. (1999) try both approaches and report that they found similar results from both.

$$(34) \quad E(Y) = \lambda = \exp(a_0 + a_1HKCR + a_2WAVE3 + a_3WAVE4 + a_4WAVE5 + a_5WAVE6 + a_6BOATOWN + a_7YRFISHST + a_8HRSF)$$

We expect the coefficient a_1 to be significantly greater than zero. However, Wang (1999) found that this estimation approach does not always yield expected catch and keep estimates that vary significantly with historic catch and keep for the big game, small game, flat fish, and bottom fish groupings.

We find a result similar to Wang (1999) with three out of four models producing statistically significant estimates of the effect of historic catch and keep rates on catch. For the red drum, spotted seatrout, and pelagic models, historic catch and keep is the most important predictor of current catch and keep. In fact, none of the independent variables in the snapper-grouper model are useful in explaining catch and keep rates. In each model the scale parameter is much larger than one, which indicates that the Poisson model without the overdispersion correction would be inappropriate.

The magnitude of the HCKR coefficient is different across models. The spotted seatrout coefficient is .29, the red drum coefficient is .85 and the pelagic coefficient is 1.4. Considering the coefficient values from Table 5-2 and the average catch and keep across anglers in Table 5-1, the marginal effect of the historic catch and keep on actual catch and keep is .60 for red drum, .67 for spotted seatrout, and 1.57 for pelagic fish.[28]

Only the pelagic fish catch and keep varies by wave with more fish being caught during Waves 4 and 5. Boat ownership has a surprisingly negative effect on spotted seatrout catch and keep. Fishing experience has a positive effect on spotted seatrout and pelagic fish catch and keep. The number of hours spent fishing has a positive effect on the catch and keep of red drum and spotted seatrout and a negative effect on pelagic fish catch and keep.

Individual Species Random Utility Models

In Table 5-3 we present individual species random utility models. These are the empirical forms of the bottom level of Figure 5-1, but instead of nesting the choices, each species has a different model. Each model includes four independent variables: travel cost, travel time, quality (mean historical or expected catch and keep), and the log of the number of MRFSS intercept sites in each county zone to account for aggregation bias (Parsons and Needleman, 1992). The deterministic part of utility is:

$$(35) \quad v_{js} = \beta_{1s}c_j + \beta_{2s}tt_j + \gamma_{1s}\log M_j + \gamma_{2s}q_{js}$$

where v_{js} is the deterministic utility for site j (j = 1,Y,68) species s (s=1,Y,4) c_j is the

[28] See Chapter 3 for a derivation of this result.

travel cost, tt_j is the travel time for those who cannot value the extra time according to the wage rate, log M_j is the log of the number of sites in the county level zone, and q_s is a catch and keep rate for species s. The catch and keep rate will be the expected catch and keep from the Poisson, which is the preferred measure, or the historic catch and keep and keep variable. As formulated, this model allows the cost coefficient (β_{1s}) to vary by species group. This is one of the disadvantages of the simple logit, because in concept one would want to constrain these parameters to be equal, because each represents the negative of the marginal utility of income.

Given the form of the logit model, when the deterministic utility increases, the probability of the alternative increases. We expect travel cost and travel time to have negative effects on the selection of a site. As the money and time cost of a trip increases, the probability that the site will be selected decreases. As the expected number of fish caught increases, whether the expected catch and keep is measured as the historic average or directly from the household production model, the probability of a site visit will be higher. Finally, the more interview sites in the county zone, the more likely that anglers visited the county zone. Thus the first two coefficients should be negative and the second two positive.

In each model the sign of the coefficient on the independent variable is in the expected direction with one exception. In the snapper-grouper model, the expected harvest has a negative effect on the selection of a site. This is probably due to the poor predictive ability of the snapper-grouper household production model. This constraint limits our ability to perform further analysis with the expected harvest variable in the snapper-grouper and the (pooled) nested logit models.

Considering first the base case model, Model 1, which considers the full 68 zone choice set and the mean historic catch and keep as the fishing quality measure, the travel cost parameter is negative and statistically significant in each species model. The travel time parameter is negative and statistically significant in the red drum and pelagic fish models. The mean historic quality variable is positive and significant in each model. The log of the number of sites in each aggregate zone is positive and statistically significant.

In Model 2 we consider the full choice set and the expected catch and keep variable as the measure of site quality. The only major difference across models 1 and 2 is the effect of site quality on site selection. For the three models that produce positive quality coefficients, the coefficient on the mean historic catch and keep variable is from two to eight times larger than the coefficient on the expected catch and keep variable. This result is potentially due to measurement error in the expected catch and keep variable. Measurement error would bias the coefficient downward.

In Model 3 we consider the restricted choice set and the mean historic catch and keep rate. The restricted choice set includes all sites within a 180 mile one-way driving distance.[29] The average number of sites in each choice set is between 12 and 13 B a large difference from the full choice set of 68 sites. Nevertheless, the choice set restriction has little effect on sign, significance, and magnitude of the coefficient estimates. Our conclusions from Chapter 4, that a roughly 3 hour drive-distance based choice set has little effect on random utility models for boat anglers, is supported with this sample of anglers.

There are also no practical differences between Model 4, in which we consider the restricted choice set and the expected catch and keep rate, and Model 2. Comparing Model 4 to Model 3, the magnitude of the quality coefficient is again at least twice as large when quality is measured with historic catch and keep.

The failure of the expected catch and keep is probably due to the poor fits, as illustrated in Table 5-2. The historic catch and keep is a significant predictor of anglers' expected catch and keep in three of the four cases. But the other determinants of expected catch and keep are not generally significant and do not tell a strong and consistent story about the determination of expected catch and keep. As a consequence, the expected catch and keep variable will have a good deal of random variation, causing the coefficient on this variable to be attenuated in the maximum likelihood estimation.

RUM Welfare Estimates

In this section we present welfare estimates of exogenous changes in fishing circumstances. The welfare exercises are somewhat different from the full model of choice. Individual anglers are constrained in two ways. First, the sample on which the species models are estimated retains only boat anglers who sought the target species. Hence other anglers, those who might target these species if the conditions improved sufficiently, would not be counted if the results were aggregated. Second, the simple logit model, where a separate model is estimated for each species, does not allow the substitution among species that would naturally occur when circumstances change differentially across species. This will tend to lead to overestimates of losses from reductions in catch and keep rates, and underestimates of gains from increases in catch and keep rates.

The estimates of compensating variation (CV) per trip for site access and a unit increase in catch and keep for a given set of sites are presented in Table 5-4. We consider each state's South Atlantic or Gulf of Mexico coastline an aggregate site. Therefore each state is one site except for Florida, which is broken down into South Atlantic (SA) and Gulf of Mexico (Gulf) sites. Conceptually, the site access welfare measures are the losses in compensating variation per trip occasion due to closure of the site to fishing the particular species. For example, the loss of red drum fishing opportunities in Alabama, which contains only two county zones, would create a $1.53 welfare loss per trip to all

[29] See Chapter 4 for further discussion of this choice set.

AMES red drum anglers (Model 1). The unit increase in catch and keep estimate is the marginal value of an increase in the historic catch and keep rate (or expected catch and keep) by one additional fish harvested at each site in the state. For example, the addition of one more red drum would increase the value of a red drum trip in Alabama by $.87 per trip.

Considering the base case Model 1, the per trip welfare measures follow the site visitation patterns. Most of the AMES trips occur in Florida and Louisiana and this is where the economic value appears when site closure is the considered policy. The largest welfare measure for site access is for a red drum trip to the Gulf coast of Florida. The loss of this opportunity would result in a $79 welfare loss for all AMES red drum anglers per trip. The Florida Gulf coast is also the highest valued spotted seatrout, pelagic and snapper-grouper trip destination.

There is little difference in the value of site closure across Models 1 B 4. The exception to this is the pelagic and snapper-grouper Models 3 and 4 for North Carolina. In these restricted choice set models the welfare losses for closure of these sites is lower than in Models 1 and 2. This result may be due to the lack of representation of these sites in the choice sets of many anglers. The loss of a site that is not in the choice set will have a limited effect on compensating variation.

The value of a unit increase in catch and keep per trip reflects the differences in the coefficients on the two measures of site quality. The value of a unit increase in catch and keep when measured with the historic average catch and keep rate is from two to ten times as great as when quality is measured with the expected catch and keep. Across models, red drum and pelagic fish have higher value than spotted seatrout and snapper-grouper. An additional red drum fish at each zone within the aggregate site is worth most in the Gulf coast of Florida and Louisiana. Spotted seatrout values per fish are always less than one dollar with one exception. Coastal migratory pelagic fish are worth most in Florida and North Carolina. Snapper-grouper fish are worth most in Florida.[30]

Further breakdowns of welfare measures by wave are possible. However, these comparisons must be used with caution for policy purposes, as the data is limited when broken down by site and wave, and the coefficients on the wave indicator variable in the Poisson model are usually not significantly different from zero. Nevertheless, consider the estimates from Model 1 of the compensating variation of site access and a unit

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[30] Note that a unit increase in the expected catch and keep and the historic catch and keep are quite different in concept. The best interpretation of the historic catch and keep is as a measure of fishing success in the past, while the expected catch and keep is our best estimate of what an angler with a given set of characteristics would catch and keep. An increase of one in the historic catch and keep might actually bring a larger or small increase in expected catch and keep, depending on the individual.

increase in catch and keep for the Gulf coast of Florida (red drum) and North Carolina (pelagic fish) by wave:

	CV by Wave			
	Site Access		Unit Increase in	
	Red Drum	Pelagic	Red Drum	Pelagic
Wave	FL (G)	NC	FL (G)	NC
2	61.58	8.23	12.64	2.07
3	86.12	71.76	16.54	16.58
4	90.73	32.48	18.12	7.75
5	78.09	73.67	13.97	18.24
6	74.37	0.24	13.34	.069

For the Gulf coast of Florida the overall site access value of $79.29 per trip overstates the value of cold weather trips (wave 2, 5 and 6) and understates the value of warm weather trips (waves 3, 4). The value of a unit increase in catch and keep is highest in Florida (Gulf) during Wave 4 and lowest during Wave 2.[31]

The value of site access is much higher during Waves 3, 4 and 5 for coastal migratory pelagic fish in North Carolina. A one unit increase in catch and keep in North Carolina is also highest in Waves 3, 4, and 5. These estimates suggest the coastal migratory pelagic fishery has little value during Wave 6 in North Carolina.

It is also interesting to compare the welfare measures that can be calculated from simple proportions of visitation and regression coefficients to the more complicated welfare estimates of random utility theory.[32] The compensating variation per trip for red drum across state is (Model 1):

Red drum	AL	FL	GA	LA	MS	NC	SC
CV/trip	0.88	21.63	0.54	13.88	0.81	0.20	6.33

The welfare estimates follow the general pattern of site visitation, the values of Florida and Louisiana trips are greatest, but the values are somewhat lower than the theoretically correct Model 1 welfare estimates in Table 5-4. The Aquick@ estimate of the value of a unit increase in catch and keep is $37.70. This is the value for an increase of one more fish at all 68 sites. The corresponding value of a unit increase in catch and

[31] Wave 1 estimates of compensating variation could be approximated by averages of the compensating variations of Waves 2 and 6.
[32] These welfare measures were derived in the appendix to Chapter 4 and used for preliminary analysis of choice sets in Chapter 4.

keep when calculated using random utility theory is identical. This result suggests that the Aquick@ welfare measures derived in Chapter 4 can be of much use for preliminary welfare analysis from RUM models.

Nested RUM Model

The nested RUM results appear in Table 5-5. The variables included in the site selection stage are the variables: travel cost, time cost, log of the number of MRFSS sites in the aggregate zone, and the mean historic catch and keep rate (HCKR) of red drum, spotted seatrout, coastal migratory pelagic and snapper-grouper fish. Each respondent is assumed to consider the quality of the site only in terms of the targeted species.[33] The inclusive value is increasing in the expected utility of the species-specific choice set. The inclusive value is the only variable included to explain species choice. Hence the deterministic utility for this model can be written:

(36) $v_{js} = \beta_1 c_j + \beta_2 tt_j + \gamma_1 \log M_j + \Sigma \gamma_{2s} q_{js} d_s$

where the sum is over the 4 species groups and d_s takes on a value of 1 for species group s and 0 otherwise. Thus there are two differences between the nested model and the simple logit model. In the nested model, the angler chooses which species to target, based on the catch and keep rate and the other variables. Further, the parameters on the non-species related variables are constrained to be equal across species.

We consider models with the full and restricted choice sets and mean historic catch and keep (Models 1 and 3) but do not pursue an analysis of the expected catch and keep rate variables due to the negative signs on catch and keep in the snapper-grouper model. If expected catch and keep nested RUM models are essential to the analysis of welfare for policy for these species (e.g., bag limits) the multiple species household production model approach should be adopted (Li, 1999).[34] We attempted this model for red drum, spotted seatrout, coastal migratory pelagic an snapper-grouper fish by pooling all 2084 anglers into a single household production model (these results are available upon request). The resulting coefficients on the inclusive values were not significantly different from zero and so these models are not presented here.

All of the variables have the expected signs and are statistically significant. Increases in travel cost and travel time has negative effects on the probability of site selection. Increases in mean historic harvest rates increase the probability of site selection. The more MRFSS intercept sites in the zonal site, the more likely the site will be chosen. The coefficients on the inclusive values (θ) are both significantly different from one indicating that the nested model is appropriate relative to a non-nested site

[33] This is operationalized by, for example, red drum anglers having zero values for weakfish, pelagic, and snapper-grouper historic catch and keep variables.
[34] This is the approach adopted in Chapters 4 and 6 of this report.

selection model of the j H s choices.[35]

A comparison of the Models 1 and 3 parameter estimates reveals little difference between the two models. The largest difference in coefficients is on the snapper-grouper catch and keep parameter, yet this is only 6%. The difference in the travel cost parameter is 5%. All other differences in parameter estimates are smaller than 5%. The likelihood ratio specification test for choice sets (at the site choice level) indicates that Model 1 is preferred (χ^2=39.69). However, the similarity of coefficient estimates indicates that there will be little practical difference in welfare measures between the two models.

Nested RUM Welfare Estimates

We focus our efforts at welfare estimation on Model 1 given the paucity of differences between Model 1 and Model 3 parameters and the statistical evidence that Model 1 is preferred. Given the structure of the nested logit model, several scenarios for welfare estimation are possible. Considering again Figure 1, it is possible to estimate the welfare loss for the elimination of any branch or limb in the decision tree down to the smallest species-site combination. The number of possibilities for site access is j H s (s_1, z_1; s_1, z_2; Y ; s_4, z_{68}). It is also possible to estimate the value of improvements in quality (q_{js}) as measured by additional mean historic catch and keep (Δq_{js} = 1, 2, etc.) for each species-site combination.

In this chapter we present only the most basic estimates: state-level site access across all species (e.g., s_1- s_4, z_1- z_2 [Alabama]), species access (e.g., s_2, z_1- z_{68}), and the value of a unit increase in mean historic catch and keep at all sites (e.g., Δq_1=1, z_1- z_{68}). We then break down species access and the value of an increase in the historic catch and keep and keep rate by state. For each scenario we present per trip and per wave estimates of compensating variation. Per wave estimates are found by multiplying per trip compensating variation by the corresponding visits variable (visits = VIS_TAR_{js}). We expect the per wave estimates for losses will tend to be too large and for gains too small, because an increase in the value per trip would be expected to increase the number of trips. All of these estimates are per angler using the private/rental boat mode.

[35] If θ = 1 then species and site choices are not correlated. The t-statistics for the null hypothesis that θ = 1 are 2.91 and 3.41 for Models 1 and 3, rejecting the null hypothesis.

Aggregate Values. Estimates of compensating variation for site access, species access, and for a unit increase in catch and keep are presented in Table 5-6. The elimination of the Gulf coast of Florida to red drum, spotted seatrout, pelagic fish, and snapper-grouper fishing would result in a welfare loss of $61 per trip occasion. The average number of trips of this type is 3.41 per wave. Aggregation of per trip compensating variation by trips yields per wave estimates of welfare loss. For the Gulf coast of Florida, this loss is $208 per wave. Other large welfare losses for site closure per wave are for the South Atlantic coast of Florida (CV = $80), Louisiana ($59), North Carolina ($42), and South Carolina ($32). The per wave welfare losses for closure of Alabama ($3), Georgia ($4), and Mississippi ($6) are relatively small, because the shoreline is small relative to the surrounding coast.

The compensating variation of a loss of species access across all 68 zones is not as variable as estimates of site access. These estimates range between $8 (spotted seatrout) and $11 (red drum) per trip. Per wave estimates of compensating variation for species access are $36 for red drum, $28 for spotted seatrout, $30 for pelagic fish, and $29 for snapper-grouper fish.

The value of an increase in the historic catch and keep rate across all sites varies considerably. The value of a one unit increase in the catch and keep rate for red drum is $10, a unit increase for spotted seatrout is $1, for pelagic fish is $29, and for snapper-grouper fish is between $7 and $8.[36] Multiplying per trip estimates by the average number of trips across wave yields per wave estimates of a unit increase in catch and keep per trip of $34 for red drum, $4 for spotted seatrout, $92 for pelagic fish, and $23 for snapper-grouper fish.

Values for Species Access by Site. The compensating variation of species access by site (state) yields lower estimates of value, relative to the individual species RUM estimates in the previous section, due to the increased substitution possibilities available to boat mode anglers (Table 5-7). For example, if North Carolina is shut down for red drum fishing, those who target red drum could travel to South Carolina or Florida for red drum fishing or target spotted seatrout, pelagic fish, or snapper-grouper in North Carolina. The values of species access per trip range from a low of $.09 (spotted seatrout in Alabama) to $4.44 (snapper-grouper fish in Gulf Florida).

The average number of species-specific visits is more variable when broken down by state. This yields more variability in the value of species access per wave. The values of species access per wave range from a low of $.21 (spotted seatrout in Alabama) to $14.58 (snapper-grouper fish in Gulf Florida). Other relatively large per wave values are Gulf Florida access to red drum ($10), spotted seatrout ($11), and pelagic fish ($11) and red drum fishing in Louisiana ($10). Loss of access to each species in Alabama and each

[36] Note that this is not the same as an increase in one fish per trip per angler, because the expected catch and keep models in general do not predict a value that high.

species other than red drum in Georgia would result in a welfare loss of less than $1.

Note that the sum of the per wave estimates for species access is less than the aggregate value of species access presented in Table 5-6. This is due to the increased substitution possibilities when the value of species access is estimated at the state level. This suggests that the welfare estimates in Table 5-7 should be considered as lower bounds when estimating the value of policy changes for large water bodies. For example, a Gulf of Mexico red snapper season that does not include a 2-month wave would result in a welfare loss of more than $18.30 (the sum of the Alabama, Gulf Florida, Louisiana, and Mississippi values).[37,38]

Values for One Unit Increase in the Catch and Keep Rate by Site. The compensating variation of a one unit increase in the historic catch and keep rate per trip by individual sites (state) yields lower estimates of value (relative to Table 5-6) due to the increased substitution possibilities available to boat mode anglers (Table 5-8). The value of a one unit increase per trip ranges from a low of $.02 (spotted seatrout in Alabama and Georgia) to a high of almost $12 (pelagic fish in Gulf Florida). The next highest value for a one unit increase in catch and keep is $6.52 and $4 for pelagic fish in Atlantic Florida and Louisiana.

Per wave values of one unit increase in red drum range from a low of $.40 in Alabama to $3 in South Carolina and Gulf Florida. Per wave estimates for spotted seatrout are all less than $1 except for Florida. A one unit increase in the catch and keep rate for pelagic fish per wave is worth $37 in Gulf Florida, $22 in Atlantic Florida, $11 in Louisiana, between $6 and $8 in Mississippi, North and South Carolina, and $2 in Alabama. The comparable change in snapper-grouper per wave is worth $11.56 in Gulf Florida, $4 in south Atlantic Florida and $2 or less in other states.

Discussion

In this chapter we demonstrate the feasibility of using AMES data to estimate random utility models models for individual species. We find that only two species, red drum and spotted seatrout, have enough data in the AMES for rigorous species-level analysis. We show, however, that realistic species groupings can be constructed to model angler behavior for important species within the groups.

The nested random utility model allows substitution across species as well as across zones. Not surprisingly, welfare estimates for site access from the nested RUM model are substantially lower than corresponding estimates from the zone choice RUM

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[37] Note also that this illustration assumes that the value of red snapper trips is equal to the value of all snapper-grouper trips.
[38] Policy-specific welfare estimates can be estimated after modifications to the SAS programs described in Appendix B.

model. Estimates of the value of site access from species (and species group)-specific non-nested random utility models should be considered upper bounds.

Similarly, since non-nested RUM models do not permit substitution across species, the values of catch rate improvements should be considered lower bounds. In a nested model, a species-specific catch rate improvement will lead to an increase in the value per trip of those who currently target that species. The catch rate improvement will also attract anglers who are currently targeting other species, increasing further the value of the catch rate improvement.

For example, consider red drum angling in North Carolina. An annual estimate of angler trips targeting red drum in North Carolina is 124,053.[39] Elimination of access to North Carolina red drum fishing would result in a welfare loss of a little more than $63 thousand using the NRUM model. The corresponding estimate from the RUM model is almost $232 thousand. This estimate is almost four times larger than the NRUM estimate. The comparison between the RUM and NRUM welfare estimates for a one unit increase in the historic catch and keep yields the opposite result. The aggregate value of a one unit increase in the red drum catch and keep rate on North Carolina trips is almost $67 thousand using the NRUM but only between $44 and $45 thousand using the RUM welfare estimates.

[39] Personal communication, Souleymane Diaby (NC, Division of Marine Fisheries).

Chapter 6
The Full Southeast MRFSS Nested Random Utility Model

In this chapter we report the results of a two-stage nested random utility model for recreational fishing in the Southeast United States. Following McConnell and Strand (1994) and Hicks, et al., (1999), the model estimated here assumes that recreational anglers first choose the mode/species combination in which they will participate, and then choose the county-level destination where they will fish. Because the MRFSS-AMES is an intercept survey, this model is conditioned on the angler having chosen to fish and as such, the fishing participation decision is not modeled.

Estimating the Model

As explained in Chapter 2, the nested random utility model of mode/species-site choice, assumes that the anglers chooses the utility maximizing mode/species-site combination. The analytical model implies that the angler makes a single utility maximizing choice from among the 1050 mode/species-site combinations: 15 mode/species and 70 sites. For estimation the mode/species-site choice can be separated into two distinct stages. The first stage decision for the angler is to choose the utility maximizing mode-species combination from fifteen possible mode-species combinations defined in Chapter 3 (Modes: Shore, Party/Charter, and Private Boat; Species: Big Game, Small Game, Flat, Bottom, and No Target/Other). Conditional on the choice of mode-species, the angler then chooses the utility maximizing site in the second stage. The usefulness of this result is that the two-stage nested random utility model can be estimated in a two-stage limited information maximum likelihood framework rather than the computationally burdensome full-information maximum likelihood framework.

Estimation of the two-stage model proceeds as follows: First, a conditonal logit model is estimated on the second stage site choice decision conditional on the angler's choice of mode/species. The site choice model is assumed to be dependent on the travel cost from the center of the home zip-code to the center of the county destination, the travel time over the same distance, and the mode/species-site specific catch and keep rate for the chosen mode-species combination.[40] Because the county level sites are aggregate sites that narrow over 1000 MRFSS intercept sites into 70 county level sites, the site choice decision will also depend on the number of MRFSS intercept sites in the destination zone. The specific form for the indirect utility function of an arbitrary angler is:

$$(37) \qquad v_{jsm} = \beta_1 c_j + \beta_2 tt_j + \gamma_1 \log M_j + \sum_{s=1}^{5} \gamma_{2s} d_s \sqrt{q_{jsm}} + \varepsilon_{jsm}$$

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[40] For complete explanations of these variables, the reader is referred to Chapter 3.

where v_{jsm} is the deterministic utility for site j (j = 1,Y,70) and mode/species sm (sm=1,Y,15), c_j is the travel cost to site j, tt_j is the travel time for those who cannot value the travel-time at the wage rate, log M_j is the correction for aggregation over NMFS intercept sites to county level sites, q_{jsm} is a measure of catch rate for species s through mode m at site j, d_s is a species dummy variable that equals 1 if species s (s=1,Y,5) is chosen, and zero otherwise, and ε_{jsm} is a generalized extreme value random error term.

Given the generalized-extreme value error assumption, the probability of an angler choosing site j conditional on mode/species choice sm is:

(38)

$$\Pr ob(j|sm) = \frac{\exp[(\beta_1 c_j + \beta_2 tt_j + \gamma_1 \log M_j + \sum_{s=1}^{5} \gamma_{2s} d_s \sqrt{q_{jsm}}) / \theta_s]}{\sum_h \exp[(\beta_1 c_h + \beta_2 tt_h + \gamma_1 \log M_h + \sum_{s=1}^{5} \gamma_{2s} d_s \sqrt{q_{hsm}}) / \theta_s}$$

This specification differs from that described in Chapter 2 in that the parameter θ_s is allowed to vary across species groups.

The second stage of the estimation procedure is a conditional logit model for mode/species choice. It is assumed that the historic catch and keep rate is the main factor in determining mode/species choice and as such, the probability of choosing mode/species sm will be a function of the mode/species-specific inclusive values (I_{sm}):

(39) $$I_{sm} = \ln(\sum_h \exp[(\beta_1 c_h + \beta_2 tt_h + \gamma_1 \log M_h + \sum_{s=1}^{5} \gamma_{2s} d_s \sqrt{q_{hsm}})\theta_s)],$$

The parameter estimates from the site choice conditional logit are used to calculate the inclusive values. The probability of choosing mode/species sm used in the second stage conditional logit estimation is:

(40) $$\Pr ob(sm) = \frac{\exp(\theta_s I_{sm})}{\sum_n \exp(\theta_s I_n)}.$$

This specification allows the inclusive value parameter to differ by species. In the subsequent, it is assumed that the inclusive value parameters for the four targeted species groups (Big Game, Small Game, Flat and Bottom) are the same (θ_T), and the inclusive value parameter for those that do not target a particular species differs $\left(\theta_{NT}\right)$. This is a reasonable specification as it is the historic catch and keep rate that is assumed to determine the species/mode choice so it would be expected that the pattern of substitution between sites will differ for those that do not target a particular species.

Welfare Measures

The standard welfare measure from a nested logit random utility recreational fishing model that is linear in travel cost compares the expected maximum utility obtainable under two different policy regimes and then converts that to a money metric by normalizing with the marginal utility of income (β_1 from above). Given the indirect utility function described above, the expected maximum utility under policy situation z (V^z) is:

$$(41) \quad V^z = \ln\left[\sum_{tm}\left(\sum_j \frac{v^z_{jtm}}{\theta_T}\right)^{\theta_T} + \sum_{nm}\left(\sum_j \frac{v^z_{jnm}}{\theta_{NT}}\right)^{\theta_{NT}}\right],$$

Where the first summation is over the 12 mode/species combinations that contain targeted species, the third summation is over the 3 mode/species combinations with no target, and v^z_{jsm} is the estimated indirect utility function evaluated at independent variable values for situation z. The expected maximum utility described here represents a policy situation that changes the indirect utility function v_{jsm} through a change in one (or more) of the independent variables. It is also possible to introduce a policy change that changes the number of sites or mode/species alternatives available to the angler. In that case, the expected maximum utility will be altered by eliminating the affected sites or alternatives from the corresponding summations in V^z. Using this notation, the willingness to pay (WTP) for a change in policy situation from z=1 to z=0 is:

$$(42) \quad WTP = \left(V^1 - V^0\right) / \beta_1$$

Model Estimation

Table 6-1 gives the mean values of the independent variable used in the full-nested RUM. The mean historic catch and keep rates are as expected with big game and flat fish having low mean catch rates, and small game being the largest. Historic catch and keep rates are used instead of predicted catch and keep from a Poisson-type expected catch model to remain consistent with previous chapters. In Chapter 5, we find that historic catch and keep rates tends to be a better measure of site quality than does predicted catch and keep for individual species models. First-stage site choice models were estimated with both historic and predicted quality and we found that historic catch provides parameter estimates that were significant and consistent with our prior expectations and previous findings. Predicted catch and keep provided parameter estimates that were either insignificant, or unbelievable (negative coefficients). In either case, the choice of catch and keep rate had little effect on the travel cost and travel time parameters.

Table 6-2 gives the limited information maximum likelihood parameter estimates for our chosen specification of the two-stage nested RUM. The results correspond with our prior expectations. Travel cost and travel time each have a negative and significant effect on site choice indicating that travel expenses and the opportunity cost of time for those at corner solutions in their labor/leisure decision are inversely related to site choice. The natural-log of the number of sites is positively related to the probability of choosing a zone indicating that the more fishing sites available in an aggregate zone, the more likely that zone is to be chosen.

Big game and flat fish have the largest marginal utilities, with flat fish ranking first.[41] Small game has a smaller marginal effect on utility than does big game. Bottom fish have the smallest marginal effect on utility, and that effect is statistically indistinguishable from zero. The catch rate for other species is negative, small in absolute terms and insignificant. This is not surprising as this group consists of a conglomerate of miscellaneous species that were not otherwise classified.

The second stage parameters also conform to reasonable prior expectations. The inclusive value parameter on targeted species is .53 indicating that the hypothesized mode/species-site choice sequence fits the current data better than a single stage conditonal logit of site choice. If the inclusive value parameter were close to one then the nested model could be rejected in favor of a simple site choice model. The inclusive value parameter for the non-targeting group is estimated at .93. Because catch rates are the sole independent variable that vary by mode/species, this large inclusive value parameter indicates that mode/species nesting may not be appropriate for those that do not target a particular species.

Welfare Estimation

The model estimates described above provide the necessary information to estimate the economic effects of various policy scenarios towards recreational fishing in the southeast. While myriad possible policies can be proposed and evaluated using these models, this chapter will focus on two particular welfare measures: The value of access to recreational fisheries in the southeast U.S, and the value of changes in catch rates for different species groups. Where appropriate and possible, the welfare measures are broken down by state, sub-region (Atlantic versus Gulf Coats) and two-month interview waves.

Table 6-3 presents the mean willingness to pay per trip for site access to a particular state across waves 2-5. The value for all waves is found as the weighted-average of the value of access in each wave. The weights are the proportion of

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[41] This result differs from the results of Hicks, et al. (1999). In their study of recreational fishing in the Northeast U.S., they find that big game catch has a larger marginal effect on utility than does flat fish catch.

observations in each wave (as reported in the last row of table 6-3). The value of access is calculated by assuming all sites within a given state and/or wave are closed for the current choice occasion for all anglers. That is, the sites are closed such that an angler will be unable to take one more trip. The all-wave value measure may be an overestimate of the annual value of access because wave 1 (January-February) is absent from this analysis. It would be expected that the value of access in the winter months is lower for the northern south Atlantic states than in warmer weather months. However, this may be mitigated by substitution to Florida and Gulf states during these months (note the large value for access to Florida in wave 2).

Before discussing the results, a word of caution is in order. It should be noted that these WTP measures should not be aggregated across states to obtain a total value of access across all states. The nested RUM model assumes that an angler chooses a site based on the set of substitute sites available. When a subset of sites is eliminated, it is assumed that the remaining sites are still available for fishing. Therefore, the value of access to North Carolina assumes that all sites in South Carolina are still available, and the value of access in South Carolina assumes that the all sites in North Carolina are still available. Aggregation of these two measures would lead to a different (and inappropriate) measure of WTP than closure of both sites simultaneously. On a related note, the values for North Carolina and Louisiana are potentially biased upward as it is assumed that sites in Virginia and Texas are unavailable to these anglers. Because the southeast MRFSS does not cover these regions, it is assumed that they are not available substitutes for North Carolina and Louisiana.

The results in table 6-3 are not surprising. Florida, North Carolina and Louisiana have the largest value of access. These three states represent the largest number of MRFSS intercept sites, the largest number of aggregated county sites, the largest amount of coastline, and the largest number of recreational fishing trips in the southeast. Three different welfare measures are reported for Florida: Loss of access to the Atlantic coast of Florida ($12.01 per trip per angler), loss of access to the Gulf coast of Florida ($45.88 per trip per angler), and complete loss of access to all sites in Florida ($202.52 per trip per angler). The Atlantic and Gulf Coast split is defined using the Atlantic/Gulf sub-region code supplied with the AMES data. The large value of access for all of Florida (relative to the value of access of to the Atlantic and Gulf Coasts independently illustrates the aggregation problem described above. When the east coast of Florida is eliminated, the west coast is still available as a viable substitute and vice-versa. However, when both are eliminated, the welfare losses are much larger as the closest available alternatives are Georgia and Alabama. The values of access to Florida, North Carolina ($15.83), and Louisiana ($11.68) are followed by the values of access to South Carolina ($6.70), Mississippi ($3.63), Georgia ($2.58), and Alabama ($1.56).

Value of Access by Wave, State and Region

Table 6-3 also reports the value of access to each state broken down by two-month waves (Wave 2 is March-April, Wave 3 is May-June, etc). The value of access varies by wave, and no clear pattern emerges between states. North Carolina has the largest values of access in late spring and early fall (waves 3 and 5), with lowest values in early spring (wave 2). The value of access to South Carolina is likewise largest in early fall (wave 5), but is fairly consistent across the other waves. The value of access to Alabama and Mississippi sites appears to be invariant to the time of year, while the values for Louisiana fluctuate by month. With the exception of Louisiana, the value of access during the summer wave (wave 4) is lower than at least one other wave.

The value of access to the South Atlantic ($109.31) is on average $27.09 higher than the value of access to the Gulf of Mexico excluding Texas ($82.22). However, the value of access in the South Atlantic tends to vary more across waves than does the value of access in the Gulf. As expected, the value during colder waves (wave 2) tends to be much lower for the South Atlantic than for the more temperate Gulf. The value of access to the Gulf is highest in wave 2.

While it would be useful to obtain a measure of value for the entire Southeast region, the current MRFSS regional intercept format is not conducive to such a welfare measure. The modeling of intercept survey data requires the conditioning of the welfare measures on at least one site being available. Elimination of access to all sites results in a complete conditional utility loss, and an infinite value for the region. To obtain a regional welfare measure it would be necessary to combine multi-regional survey data (for example, combining the southeast and the northeast intercept survey results). As the current survey protocol dictates independent administration of the regional surveys, combining survey data could prove to be a tremendous task.

Catch and Keep Rate Welfare Measures

Table 6-4 reports the willingness to pay for a one-unit increase in historic catch rate by state and species. The value of increasing the historic catch rate by one-unit does not vary significantly across states implying that catch rates do not vary widely by state on average. The value however, does vary significantly across species. Corresponding to the large estimated marginal utility of flat fish catch in Table 6-2, the value of increasing historic catch and keep is largest for additional flat fish ($23.67) at sites on the east coast of Florida. Big Game ranks second ($14.83 per angler per trip), with small game and bottom fish following.

Discussion

The welfare estimates provided here represent two of a large number of possible policy effects that can potentially be measured. Management efforts aimed at specific species through gear restrictions will be difficult to value using the results obtained here because of the poor performance of predicted catch on recreational site choice. To incorporate the effects of gear restrictions a behavioral link is needed between individual behavior, and site choice. Because gear typically does not vary by site that link must come indirectly through the Poisson type predicted catch equations.

Bag limits will also be difficult to evaluate without a better link between expected catch and site choice. The current model uses average historic catch and keep as a proxy for expected catch and keep, but changing historic catch and keep to reflect future bag limits is questionable at best. As Hicks, et al., (1999) and the current study have found, establishing a link between predicted catch and site choice behavior is a daunting task using the MRFSS-AMES data.

Chapter 7
Conclusions

In this report we estimated economic values associated with access to fishing sites and the quality of marine recreational fishing in the United States from North Carolina to Louisiana. We use MRFSS-AMES data, which supports a broad range of policy-relevant models of marine recreational fishing. The data is somewhat limited in that almost one-half of all AMES anglers do not target species on their MRFSS interview. This significantly reduces the sample size available for estimation of household production and random utility models that are based on the choice of species.

Several measures of fishing quality are examined. The first measure is the species, mode, and wave-specific 5-year historic catch rates at each site. With this measure we find that historic catch rates, including fish discarded, are too noisy for use in random utility models. We focus our attention on the second measure of fishing quality: harvest, or catch and keep, rates. With historic catch and keep rates we are able to estimate nested random utility models and perform welfare calculations.

Another measure of fishing quality assessed is the estimate from household production models, conditional on the historic catch and keep rates, of the number of species, mode, and wave-specific fish expected to be caught by anglers at each site. We find that the MRFSS-AMES data does not fully support individual species household production models. In these models, the relationship between actual catch and keep and historic catch and keep is not always statistically significant. This result is essential for obtaining estimates of quality that vary across fishing site.

We adopted a pooled household production model. In the pooled models the effect of mean historic catch and keep on individual harvest is constrained to be equal across species. Species-specific dummy variables are used to obtain variation in estimates of species harvest across site. These estimates provide good predictive power at the site choice stage of the nested random utility models. However, we find that the nested random utility models are not sensitive to the predicted estimates of site quality at the species choice and species-mode choice stage. Most of our welfare estimates are from models using historic catch and keep as the measure of site quality.

Angler behavior is estimated with the nested random utility model. Anglers are assumed to choose fishing mode and target species and then choose where to fish. The determinants of site choice include the site-specific cost and the quality of the fishing trip. We first examined the optimal choice structure in terms of distance-based and catch-based choice sets. Throughout our analysis we find that our estimated models are not sensitive to these choice sets.

We find that the AMES data will support individual species level analyses for red drum and spotted seatrout. Other species of interest to the NMFS are included in species groups. We estimate one-level (non-nested) site choice and two-level (nested) species, site choice random utility models. We find that species substitution is an important factor in the behavior of anglers. In other words the nested model is more appropriate.

We replicate the mid-Atlantic and northeast species-mode, site choice nested random utility model of marine recreational fishing (Hicks, et al., 1999) with the southeast MRFSS-AMES data. One major difference in the two models is that the southeast model must be amended to account for the large number of anglers who do not target species.

We estimate three types of economic values. The first is the value of access to fishing sites. We focus on aggregated sites because the values for county level sites tend to be quite low given the large number of substitute sites. For most of our models, the value of site access to Florida and Louisiana are largest because most of the AMES anglers visited these states. When comparing the value of site access, non-nested models lead to values that are biased upward relative to nested models.

The second welfare measure is the value of species access. This welfare measure can only be estimated in nested random utility models. We find that, while there is significant potential species substitution in the southeast recreational fishery, the value of access to certain species is large.

The third type of welfare measure is the value associated with changes in the ability of anglers to catch fish. We estimate the value of unit increases in historic catch and keep for both individual species and species groups. Our ability to estimate the value of bag limits is hindered by the inability of the household production model to accurately estimate predicted catch rates. Bag limits are difficult to evaluate without a reliable link between expected catch and site choice. The current model uses average historic catch and keep as a proxy for expected catch and keep, but changing historic catch and keep to reflect future bag limits is questionable at best. Establishing a link between predicted catch and site choice behavior is a daunting task using the MRFSS-AMES data.

Aggregate values for recreational fishing in the Southeast and for species groups can be obtained by combining the values reported here with aggregate trip information available from the National Marine Fisheries Service Southeast Regional Office. The number of trips is calculated using the MRFSS intercept data along with interview intensity data to predict the number of trips taken in 1997. This data along with the values provided here will provide estimates of the aggregate willingness to pay for a one day fishing trip in the Southeast, and aggregate willingness to pay for a one unit increase in historical catch rates.

Future research efforts should be devoted to several issues. First, we estimate 5-year historic catch rates by assigning zero catch rates to species/mode/wave specific catch rates that are not observed in the data. In general, this approach is successful since actual catch and keep tends to be related to historic catch and keep, as measured. However, this approach is ad-hoc and alternative imputation methods could be examined. For example, using similar sites, zones, waves or years to estimate missing historic catch and keep rates could be pursued. Or, we could reduce the level of detail in catch rates to minimize the missing values problem. Any differences could potentially affect household production and random utility model estimates.

An important feature of random utility models is the ability to estimate the value of policies that affect individual anglers' ability to catch fish, such as bag limits. To accurately estimate these values it is essential that the expected catch and keep rate is used to measure site quality, relative to historic catch and keep rates. Future research with the AMES data should explore alternative household production and nested random utility models that are better able to capture this relationship.

Third, alternative nesting structures should be examined to determine the appropriate choice set. For example, in our analysis of the individual species we essentially excluded shore and charter/party boat trips from the choice set. An important consideration is the effect of this choice on the value of sites and species access and the value of increases in catch rates. We also excluded multi-day trips from all models. Future research could estimate a larger model in which anglers first choose the length of trip, single or multi-day, and then choose species/mode and site.

Fourth, investigations into combining regional MRFSS survey results could prove promising in estimating regional values for recreational fishing, and provide guidance to survey designers and administrators. For example, can model estimation in the southeast region provide information about the values in the northeast. Are value measures transferable between regions? Are value measures from the MRFSS stable across time? Answers to such questions could allow for more efficient timing and less burdensome design of surveys.

Finally, alternative models could be estimated focusing on the definition of targeted species. In our models we used the species that the angler was primarily targeting (PRIM1) from the MRFSS. Other measures of species targeting are included in the MRFSS (PRIM1) and the AMES (gen_tar1 B gen_tar4). The AMES data in particular includes several measures of targeting not related to the particular trip from the MRFSS. These alternative measures could be used to estimate models for single species for which the number of anglers primarily targeting the species is not large enough for random utility modeling.

References

Bockstael, N., K. McConnell, and I Strand Recreation in *Measuring the Demand for Environmental Quality.* Eds Braden, J. and C. Kolstad. North-Holland Publishers: Amsterdam, 1991.

Cameron, A. Colin, and Pravin K. Trivedi, "Econometric Models Based on Count Data: Comparisons and Applications of Some Estimators and Tests," Journal of Applied Econometrics, 1: 29-53, 1986.

Greene, Gretchen, Charles B. Moss, and Thomas H. Spreen, "Demand for Recreational Fishing in Tampa Bay, Florida: A Random Utility Approach," Marine Resource Economics, 12: 293-306, 1997.

Haab, T. and R. Hicks, "Accounting for Choice Set Endogeneity in Random Utility Models of Recreation Demand," Journal of Environmental Economics and Management, 34: 127-47, 1998.

Haab, Timothy C. and John C. Whitehead, AThe Economic Value of Marine Recreational Fishing in the Southeast United States: 1997 Southeast Economic Data Analysis,@ Progress Report, < http://personal.ecu.edu/whiteheadj/nmfs/progress.pdf >, September 1999.

Hicks R. and I. Strand, "The Extent of Information: Its Relevance for RUM Models." Land Economics, forthcoming.

Hicks, Rob, Scott Steinbeck, Amy Gautam, and Eric Thunberg, AVolume II: The Economic Value of New England and Mid-Atlantic Sportfishing in 1994, NOAA Technical Memorandum NMFS-F/SPO-38, August 1999.

Kling C. and C. Thompson, "The Implications of Model Specification for Welfare Estimation in Nested Logit Models." American Journal of Agricultural Economics,78: 103-14, 1996.

Li, Li, " Selection of Site-Specific Fishing Quality Estimation Methods," MS in Applied and Resource Economics Research Paper, East Carolina University, < http://www.econ.ecu.edu/ecer/lili.pdf >, June 1999.

McConnell, K. and I. Strand, "The Economic Value of Mid and South Atlantic Sportfishing: Volume 2." Cooperative Agreement #CR-811043-01-0 between the University of Maryland at College Park, the Environmental Protection Agency, the National Marine Fisheries Service, and the National Oceanic and Atmospheric Administration, 1994.

McConnell, K., I. Strand and L. Blake-Hedges, "Random Utility Models of Recreational

Fishing: Catching Fish Using a Poisson Process." Marine Resource Economics, 10: 247-61, 1995.

McFadden, D., AThe Measurement of Urban Travel Demand,@ Journal of Public Economics, 3, 303-328, 1974.

McFadden, D., AModeling the Choice of Residential Location,@ Spatial Interaction Theory and Residential Location, A. Karlquist, L. Lundquist, F. Snickers, and J. Weibull, eds., New York, 1978.

Morey, Edward R. AWhat Is Consumer Surplus per Day of Use,@ Journal of Environmental Economics and Management, 26:271-282. 1994.

_____ ATwo RUMS unCLOAKED: Nested-Logit Models of Site Choice and Nested Logit Models of Participation and Site Choice@ in (Herriges and Kling, editors) Valuing Recreation and the Environment, 65-120, Edward Elgar, 1999.

National Marine Fisheries Service, Office of Science and Technology, Fisheries Statistics and Economics Division, AMarine Recreational Fisheries Statistics: Data User's Manual,@ http://www.st.nmfs.gov/st1/recreational/research/procedures.html, July 12, 1999.

Parsons, George R., Paul M. Jakus, Ted Tomasi, AA Comparison of Welfare Estimates from Four Models for Linking Seasonal Recreational Trips to Multinomial Logit Models of Site Choice,@ Journal of Environmental Economics and Management, Vol. 38, No. 2, pp. 143-157, 1999.

Parsons, G. and A. Hauber, "Spatial Boundaries and Choice Set Definition in a Random Utility Model of Recreation Demand." Land Economics, 74(1): 32-48, 1997.

Parsons, George R., and Michael S. Needelman, ASite Aggregation in a Random Utility Model of Recreation,@ Land Economics, 68(4): 418-433, 1992.

Parsons, George R., Andrew. Plantinga and Kevin Boyle, "Narrow Choice Sets in a Random Utility Model of Recreation Demand,@ Land Economics, 76(1):86-89.

QuanTech, Survey Research Center, A1997 AMES Telephone Follow-Up Survey Coding Handbook, 1998.

Schuhmann, Pete, ADeriving Species-Specific Benefits Measures for Expected Catch Improvements in a Random Utility Framework.@ Marine Resource Economics, 13:1-21, 1998.

Smith, V. K., J. Liu and R. Palmquist, "Marine Pollution and Sport Fishing Quality: Using Poisson Models as Household Production Functions." Economics Letters, 42: 111-16, 1993.

Strand, I., K. McConnell, N. Bockstael, and D. Swartz, "Marine Recreational Fishing in the Middle and South Atlantic: A Descriptive Study." Cooperative Agreement #CR-811043-01-0 between the University of Maryland at College Park, the Environmental Protection Agency, the National Marine Fisheries Service, and the National Oceanic and Atmospheric Administration, 1991.

Thomson, Cynthia J., AEffects of Avidity Bias on Survey Estimates of Fishing Effort and Economic Value,@ in Creel and Angler Surveys in Fisheries Management, American Fisheries Society Symposium 12:356-366, 1991.

Wang, Yang, "A Model of Marine Recreational Fishing Demand: Using a Poisson Process," MS in Applied and Resource Economics Research Paper, East Carolina University, < http://www.econ.ecu.edu/ecer/yangwang.pdf >, June 1999.

Figure 5-1. Nested Random Utility Model

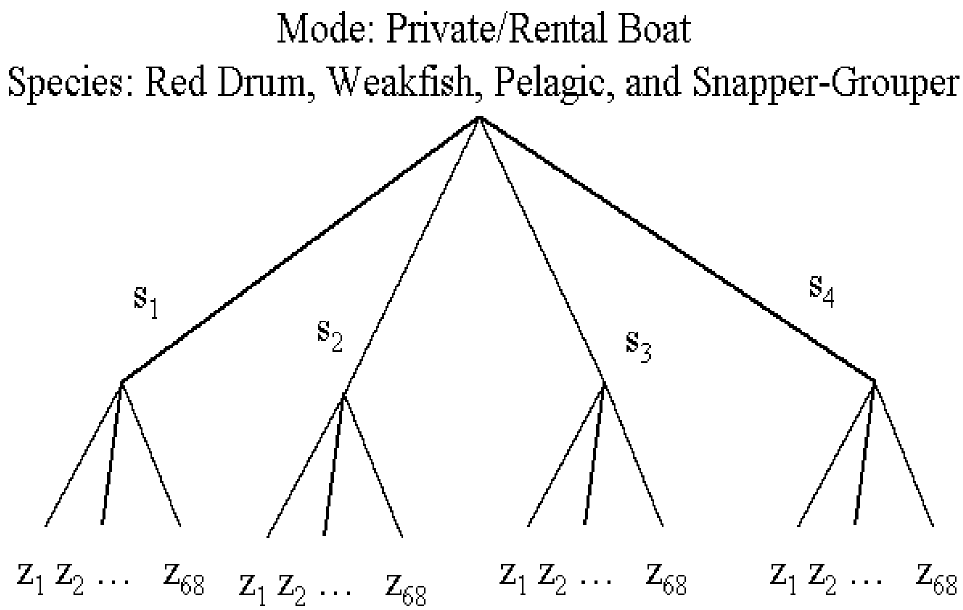

Figure 6-1. Nested Random Utility Model

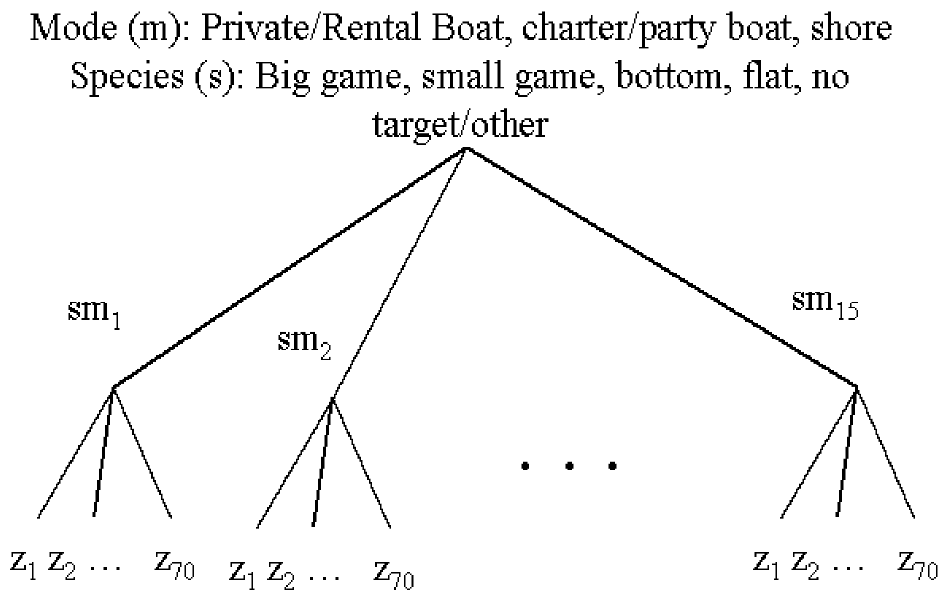

Table 3-1. Fishing Mode Choices

Mode	Frequency	Percent
party/charter	906	10.1
private/rental	5370	60.1
shore	2652	29.7

Table 3-2. Species Group Choice

Species	Frequency	Percent
Big	444	5
Small	2882	32.3
Bottom	657	7.4
Flat	293	3.3
Other	4652	52.1

Table 3-3. Species/Mode Choices

Species	Mode	Frequency	Percent
big	party/charter	85	1
big	private/rental	337	3.8
big	shore	22	0.2
small	party/charter	154	1.7
small	private/rental	2175	24.4
small	shore	553	6.2
flat	party/charter	0	0
flat	private/rental	205	2.3
flat	shore	88	1
bottom	party/charter	100	1.1
bottom	private/rental	353	4
bottom	shore	204	2.3
other	party/charter	567	6.4
other	private/rental	2300	25.8
other	shore	1785	20

Table 3-4. Zone Choices

STATE	COUNTY	Frequency	Percent	Number of Sites in Zone
Alabama	BALDWIN	183	2	28
Alabama	MOBILE	165	1.8	13
Florida	BAY	89	1	146
Florida	BREVARD	379	4.2	68
Florida	BROWARD	109	1.2	34
Florida	CHARLOTTE	71	0.8	32
Florida	CITRUS	127	1.4	30
Florida	COLLIER	43	0.5	29
Florida	DADE	132	1.5	28
Florida	DIXIE	41	0.5	27
Florida	DUVAL	74	0.8	24
Florida	ESCAMBIA	31	0.3	22
Florida	FRANKLIN	31	0.3	21
Florida	GULF	14	0.2	21
Florida	HERNANDO	116	1.3	20
Florida	HILLSBOROUGH	308	3.4	19
Florida	INDIAN RIVER	89	1	19
Florida	LEE	168	1.9	18
Florida	LEVY	187	2.1	16
Florida	MANATEE	187	2.1	15
Florida	MARTIN	243	2.7	15
Florida	MONROE	533	6	14
Florida	NASSAU	48	0.5	14
Florida	OKALOOSA	129	1.4	13
Florida	PALM BEACH	278	3.1	12
Florida	PASCO	293	3.3	12
Florida	PINELLAS	627	7	10
Florida	ST JOHNS	48	0.5	9
Florida	ST LUCIE	121	1.4	9
Florida	SANTA ROSA	26	0.3	7
Florida	SARASOTA	166	1.9	7
Florida	TAYLOR	37	0.4	7
Florida	VOLUSIA	24	0.3	7
Florida	WAKULLA	9	0.1	5
Florida	WALTON	6	0.1	4
Georgia	BRYAN	3	0	25
Georgia	CAMDEN	1	0	22

Georgia	CHATHAM	163	1.8	8
Georgia	GLYNN	63	0.7	7
Georgia	LIBERTY	12	0.1	6
Georgia	MCINTOSH	15	0.2	5
Louisiana	CALCASIEU	23	0.3	17
Louisiana	CAMERON	24	0.3	14
Louisiana	JEFFERSON	172	1.9	12
Louisiana	LAFOURCHE	92	1	10
Louisiana	ORLEANS	89	1	10
Louisiana	PLAQUEMINES	265	3	8
Louisiana	ST BERNARD	126	1.4	7
Louisiana	ST MARY	5	0.1	6
Louisiana	TAMMANY	67	0.8	4
Louisiana	TERREBONNE	118	1.3	2
Louisiana	VERMILLION	5	0.1	1
Mississippi	HANCOCK	27	0.3	22
Mississippi	HARRISON	185	2.1	11
Mississippi	JACKSON	49	0.5	11
North Carolina	BEAUFORT	7	0.1	66
North Carolina	BRUNSWICK	2	0	52
North Carolina	CARTERET	447	5	34
North Carolina	DARE	978	11	16
North Carolina	HYDE	28	0.3	14
North Carolina	NEW HANOVER	1	0	9
North Carolina	ONSLOW	78	0.9	9
North Carolina	PAMILICO	1	0	8
North Carolina	PENDER	3	0	2
South Carolina	BEAUFORT	83	0.9	35
South Carolina	BERKELEY	34	0.4	34
South Carolina	CHARLESTON	146	1.6	11
South Carolina	COLLETON	14	0.2	9
South Carolina	GEORGETOWN	222	2.5	5
South Carolina	HORRY	248	2.8	4

Table 3-5. Data Summary: South Atlantic Anglers

Variable	N	Mean	Std Dev	Minimum	Maximum
HH_INCOM	2711	54.1	34.9	7.5	200
EMPLOYED	4145	0.76	0.43	0	1
WHITE	4195	0.91	0.28	0	1
AGE2	4131	45.14	14.07	14	97
YRSFISH	4096	21.95	15.17	0	93
YRFISHST	4112	17.3	13.87	0	85
TRIPS	4083	7.37	8.71	1	60
MODE_TRP	4064	5.9	7.66	0	60
MODE_TAR	4004	4.67	6.52	0	60
VISIT	4047	4.49	6.53	1	60
VIS_MODE	4043	4.34	6.34	0	60
VIS_TAR	4005	3.69	5.63	0	60
OVTRIP	4067	0.79	2.35	0	35
BOATOWN	4191	0.55	0.5	0	1
PARTY	2590	2.62	1.41	1	14
HRSF	4188	4.44	2.09	0.5	23.5
MULTI	4195	0.33	0.47	0	1
TRIP_DAY	4190	2.29	7.42	0	210
FISH_DAY	4185	1.62	5.79	0	210
LODGEXP	3896	79.77	322.67	0	8000
TIMETRAV	3981	133.74	240.06	0	930
TIMESITE	4174	49.47	75.53	0	900
TRAVEXP	4121	48.63	217.87	0	8090
OTHEXP	4130	25.38	139.49	0	8000
FFDAYS2	4135	7.15	9.57	0	62
FFDAYS12	4095	35.85	51.63	0	364

Table 3-6. Data Summary: Gulf of Mexico Anglers

Variable	N	Mean	Std Dev	Minimum	Maximum
HH_INCOM	3185	52.97	36.63	7.5	200
EMPLOYED	4953	0.77	0.42	0	1
WHITE	5006	0.91	0.28	0	1
AGE2	4935	43.7	14.23	14	96
YRSFISH	4887	21.05	15	0	83
YRFISHST	4899	16.62	13.92	0	80
TRIPS	4893	6.94	8.59	1	61
MODE_TRP	4869	5.38	7.38	0	61
MODE_TAR	4795	4.54	6.5	0	61
VISIT	4841	4.13	6.27	1	61
VIS_MODE	4836	4.05	6.19	0	61
VIS_TAR	4788	3.39	5.28	0	61
OVTRIP	4878	0.56	2.08	0	60
BOATOWN	4996	0.6	0.49	0	1
PARTY	3916	2.96	1.84	1	23
HRSF	4996	4.36	2.06	0.5	23.5
MULTI	5006	0.24	0.42	0	1
TRIP_DAY	5001	1.94	10.73	0	300
FISH_DAY	4993	1.02	6.12	0	235
LODGEXP	4818	57.1	313	0	7000
TIMETRAV	4790	81.97	194.72	0	997
TIMESITE	4981	50.09	67.17	0	700
TRAVEXP	4925	33.17	152.9	0	5000
OTHEXP	4938	21.26	115.01	0	4000
FFDAYS2	4969	6.66	9.31	0	60
FFDAYS12	4908	37.78	52.29	0	364

Table 3-7. Poisson Household Production Model

Dependent Variable = Catch and Keep per Trip*

Variable	Beta	Standard Error	t-statistic	Variable Mean
INTERCEPT	-2.254	0.398	-5.67	
BIG	1.012	0.437	2.31	0.05
BOTTOM	2.111	0.318	6.64	0.08
SMALL	2.083	0.268	7.76	0.37
FLAT	2.045	0.444	4.60	0.03
WAVE3	0.183	0.234	0.78	0.24
WAVE4	0.356	0.238	1.50	0.17
WAVE5	0.504	0.221	2.28	0.22
WAVE6	0.323	0.231	1.40	0.20
MODE2	-0.809	0.217	-3.73	0.71
MODE3	-1.354	0.266	-5.08	0.24
HCKR	0.202	0.025	8.22	0.97
HRSF	0.114	0.031	3.64	4.33
YRFISHST	0.025	0.009	2.92	18.63
YRFISHST Squared	-0.000	0.000	-2.00	613.4
BOATOWN	-0.154	0.150	-1.03	0.63
SCALE	5.031			

Sample Size = 6379

*Mean of dependent variable = 0.47.

Table 4-1. Number of Sites in Each Choice Set

Choice Set	Maximum Distance	Minimum Historic Rate	Mean	SD	MIN	MAX
1			70.00			
2	360		27.91	7.10	2	43
3	300		23.95	5.79	3	35
4	240		19.15	4.20	3	28
5	180		13.50	2.73	2	19
6		0.25	60.71	3.26	55	68
7		0.33	57.50	2.85	53	64
8		0.5	51.81	4.28	45	61
9	300	0.25	21.40	5.31	2	33
10	180	0.25	12.37	2.83	2	19

Table 4-2. Characteristics of Small Game, Boat Fishing, Day Trippers

Variable	Mean	SD
Intercept Site:		
Alabama	0.02	0.14
Florida -South Atlantic	0.15	0.36
Florida - Gulf of Mexico	0.43	0.5
Georgia	0.01	0.12
Louisiana	0.22	0.42
Mississippi	0.02	0.15
North Carolina	0.06	0.23
South Carolina	0.08	0.27
Visits to Site/Mode/Species	3.66	4.48
Years Fished in State	20.63	16.28
Household Income (in thousands)	50.73	29.4
Historic (Targeted) Harvest Rate	1.51	1.64
Predicted (Targeted) Harvest Rate	1.78	5.96

Sample Size = 1914

Table 4-3. Conditional Logit Regression Estimates

Set	Variables	Historic Catch and Keep			Predicted Catch and Keep		
		Beta	SE	t-stat	Beta	SE	t-stat
1	Trip Cost	-0.057	0.001	-43.40	-0.057	0.001	-43.50
	Quality	0.083	0.025	3.30	0.211	0.043	4.97
	Log-Likelihood	-3191.40			-3185.406		
2	Trip Cost	-0.057	0.001	-43.30	-0.057	0.001	-43.40
	Quality	0.084	0.025	3.34	0.212	0.043	4.98
	Log-Likelihood	-3186.146			-3180.214		
3	Trip Cost	-0.057	0.001	-43.29	-0.057	0.001	-43.38
	Quality	0.084	0.025	3.34	0.212	0.043	4.97
	Log-Likelihood	-3185.932			-3180.00		
4	Trip Cost	-0.057	0.001	-43.17	-0.057	0.001	-42.93
	Quality	0.085	0.025	3.36	0.212	0.043	4.98
	Log-Likelihood	-3183.163			-3177.264		
5	Trip Cost	-0.056	0.001	-41.58	-0.056	0.001	-41.67
	Quality	0.085	0.025	3.35	0.211	0.042	4.96
	Log-Likelihood	-3175.122			-3169.313		
6	Trip Cost	-0.056	0.001	-42.81	-0.056	0.001	-42.97
	Quality	0.040	0.026	1.54	0.177	0.043	4.09
	Log-Likelihood	-3052.457			-3045.895		
7	Trip Cost	-0.055	0.001	-42.62	-0.055	0.001	-42.85
	Quality	0.007	0.027	0.28	0.153	0.044	3.47
	Log-Likelihood	-2956.67			-2951.087		
8	Trip Cost	-0.053	0.001	-41.69	-0.053	0.001	-42.09
	Quality	-0.036	0.028	-1.30	0.119	0.045	2.65
	Log-Likelihood	-2951.087			-2679.885		
9	Trip Cost	-0.054	0.001	-42.91	-0.055	0.001	-43.04
	Quality	0.049	0.026	1.89	0.182	0.043	4.23
	Log-Likelihood	-3076.950			-3070.438		
10	Trip Cost	-0.053	0.001	-40.77	-0.054	0.001	-40.91
	Quality	0.049	0.026	1.89	0.181	0.043	4.20
	Log-Likelihood	-3063.492			-3057.096		

Table 4-4. Compensating Variation per Trip for Site Access

	State							
	AL	FL (SA)	FL (Gulf)	GA	LA	MS	NC	SC
	Historic Catch and Keep Rate							
MIN	0.35	2.64	7.56	0.18	3.87	0.35	1.06	1.41
MED	0.36	2.69	7.72	0.18	3.95	0.36	1.08	1.44
MAX	0.38	2.83	8.12	0.19	4.16	0.38	1.13	1.51
	Predicted Catch and Keep Rate							
MIN	0.35	2.63	7.55	0.18	3.86	0.35	1.05	1.40
MED	0.36	2.69	7.70	0.18	3.94	0.36	1.07	1.43
MAX	0.37	2.81	8.04	0.19	4.12	0.37	1.12	1.50

Table 4-5. Compensating Variation per Wave for Site Access

	State							
	AL	FL (SA)	FL (Gulf)	GA	LA	MS	NC	SC
	Historic Catch and Keep Rate							
MIN	0.82	11.42	29.57	0.59	11.45	1.14	3.68	4.99
MED	0.83	11.66	30.19	0.61	11.69	1.16	3.76	5.10
MAX	0.88	12.27	31.76	0.64	12.30	1.22	3.96	5.36
	Predicted Catch and Keep Rate							
MIN	0.81	11.40	29.51	0.59	11.43	1.13	3.67	4.98
MED	0.83	11.63	30.10	0.60	11.66	1.16	3.75	5.08
MAX	0.87	12.15	31.45	0.63	12.18	1.21	3.92	5.31

Table 4-6. Compensating Variation per Fish

Set	Historic Catch and Keep Rate	Predicted Catch and Keep Rate
1	1.47	3.71
2	1.49	3.72
3	1.49	3.72
4	1.50	3.74
5	1.52	3.77
6	0.72	3.18
7	0.14	2.79
8	-0.68	2.22
9	0.90	3.34
10	0.92	3.38

Table 5-1. Data Summary

Variable	Mean	Std. Dev.	Mean	Std. Dev.
	Red Drum		Spotted Seatrout	
HARVEST	0.71	1.96	2.32	7.71
HCKR	0.69	0.76	1.86	2.16
BOATOWN	0.8	0.4	0.79	0.41
YRFISHST	19.34	14.34	21.57	15.05
HRSF	4.63	1.79	4.53	1.73
TRIPS	6.97	6.92	7.00	7.14
VIS_TAR	3.39	3.83	3.53	4.38
DISTANCE	50.77	94.12	43.94	84.71
INCOME	49.49	28.55	47.05	25.79
AGE	43.37	13.68	45.85	14.67
Cases	657		740	
	Coastal Migratory Pelagic		Snapper-Grouper	
HARVEST	1.12	3.39	2.01	3.7
HCKR	0.27	0.24	0.53	0.37
BOATOWN	0.81	0.39	0.79	0.41
YRFISHST	18.51	13.19	19.07	14.00
HRSF	4.63	1.93	4.61	2.28
TRIPS	7.71	8.08	6.77	6.73
VIS_TAR	3.22	3.86	3.07	3.09
DISTANCE	46.54	75.12	37.13	64.11
INCOME	56.37	32.39	49.86	29.76
AGE	41.79	11.62	43.95	12.89
Cases	507		180	

Table 5-2. Poisson Household Production Models

	Red Drum		Spotted Seatrout		Coastal Migratory Pelagic		Snapper-Grouper	
Variable	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat
INTERCEPT	-1.681	-3.45	-1.314	-2.98	-0.732	-1.62	-0.114	-0.17
HCKR	0.851	6.93	0.292	8.70	1.409	3.71	-0.296	-0.78
WAVE3	-0.151	-0.37	-0.184	-0.49	0.347	0.92	-0.403	-0.79
WAVE4	-0.467	-1.07	0.214	0.60	0.693	1.77	0.153	0.30
WAVE5	-0.350	-0.89	0.422	1.27	1.250	3.26	-0.269	-0.46
WAVE6	-0.548	-1.29	0.055	0.15	0.560	1.19	0.628	1.28
BOATOWN	0.051	0.19	-0.436	-2.13	-0.215	-0.82	0.604	1.53
YRFISHST	0.005	0.68	0.017	2.95	0.024	3.16	0.015	1.64
HRSF	0.135	2.33	0.228	4.33	-0.103	-1.74	0.020	0.32
SCALE	2.234		3.725		2.536		2.424	

Table 5-3. Random Utility Models

	Full Choice Set				Restricted Choice Set			
	Model 1		Model 2		Model 3		Model 4	
				Red Drum				
Variable	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat
Travel Cost	-0.023	-6.51	-0.022	-6.47	-0.022	-6.05	-0.021	-5.99
Travel Time	-0.535	-10.20	-0.517	-10.10	-0.525	-9.65	-0.506	-9.51
Mean HCKR	0.852	10.74			0.870	10.77		
Expected HCKR			0.409	7.95			0.419	7.85
Log(Sites)	0.363	5.01	0.429	5.99	0.357	4.93	0.426	5.96
Chi-Square	3395		3338		1238		1179	
Choices (Zones)	44676 (68)				8782 (13.27)			
				Spotted Seatrout				
Variable	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat
Travel Cost	-0.066	-5.78	-0.066	-5.85	-0.065	-5.69	-0.066	-5.75
Travel Time	-0.042	-0.30	-0.032	-0.23	-0.034	-0.24	-0.023	-0.16
Mean HCKR	0.161	6.03			0.160	5.99		
Expected HCKR			0.047	3.09			0.046	3.06
Log(Sites)	0.289	4.28	0.296	4.40	0.289	4.27	0.294	4.388
Chi-Square	3834		3809		1389		1365	
Choices (Zones)	50320 (68)				9895 (13.25)			
				Coastal Migratory Pelagic				
Variable	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat
Travel Cost	-0.026	-7.03	-0.025	-7.03	-0.025	-6.67	-0.024	-6.68
Travel Time	-0.444	-7.95	-0.445	-8.13	-0.426	-7.39	-0.428	-7.58
Mean HCKR	1.655	6.94			1.627	6.84		
Expected HCKR			0.197	2.95			0.191	2.87
Log(Sites)	0.976	11.55	1.067	12.79	0.975	11.55	1.065	12.79
Chi-Square	2856		2821		1114		1079	
Choices (Zones)	34476 (68)				6376 (11.81)			
				Snapper-Grouper				
Variable	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat
Travel Cost	-0.080	-3.57	-0.080	-3.53	-0.080	-3.52	-0.080	-3.50
Travel Time	-0.248	-0.86	-0.249	-0.86	-0.232	-0.79	-0.232	-0.79
Mean HCKR	0.801	2.44			0.813	2.47		
Expected HCKR			-0.929	-1.96			-0.934	-1.97
Log(Sites)	0.919	6.31	0.934	6.33	0.936	6.37	0.951	6.39
Chi-Square	1148		1146		537		535	
Choices (Zones)	12240 (68)				2319 (12.44)			

Table 5-4. RUM Welfare Estimates: Compensating Variation per Trip

	Site Access				Unit Increase in Catch and Keep			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
				Red Drum				
AL	1.53	1.32	1.52	1.30	0.87	0.37	0.87	0.37
FL (SA)	8.73	9.32	8.57	9.18	3.39	1.65	3.56	1.75
FL (Gulf)	79.29	79.82	82.40	83.07	14.95	7.34	15.77	7.80
GA	3.04	2.75	3.09	2.82	1.88	0.71	1.91	0.73
LA	51.10	42.73	48.08	39.33	11.54	5.41	12.14	5.74
MS	1.99	3.03	2.06	3.15	1.65	1.02	1.76	1.10
NC	1.87	1.89	3.03	3.05	0.36	0.17	0.37	0.18
SC	20.79	21.71	22.61	23.84	5.13	2.52	5.44	2.69
				Spotted Seatrout				
AL	0.39	0.41	0.39	0.41	0.05	0.01	0.05	0.01
FL (SA)	5.28	5.21	5.37	5.28	0.24	0.07	0.84	0.07
FL (Gulf)	31.35	31.42	32.27	1.02	1.02	0.29	0.44	0.29
GA	0.75	0.74	0.76	0.74	0.06	0.02	0.06	0.02
LA	14.70	13.55	13.05	11.91	0.71	0.20	0.71	0.2
MS	1.79	1.92	1.79	1.93	0.19	0.06	0.19	0.06
NC	4.05	4.03	3.18	3.17	0.11	0.03	0.11	0.03
SC	2.42	2.39	2.46	2.43	0.10	0.03	0.10	0.03
				Coastal Migratory Pelagic				
AL	1.07	0.86	1.08	0.86	1.05	0.09	1.05	0.09
FL (SA)	56.47	53.69	58.43	55.56	28.78	3.25	28.84	3.20
FL (Gulf)	59.57	62.75	62.16	65.05	24.33	2.75	24.51	2.72
GA	0.87	0.87	0.92	0.94	1.67	0.13	1.67	0.13
LA	0.84	0.84	0.35	0.35	0.42	0.05	0.43	0.05
MS	0.53	0.71	0.53	0.71	0.73	0.08	0.73	0.08
NC	42.22	40.68	33.96	32.60	10.07	1.20	10.11	1.19
SC	6.29	6.50	6.51	6.69	3.80	0.43	3.68	0.41
				Snapper-Grouper				
AL	1.88	1.74	1.89	1.73	0.62	-0.61	0.64	-0.61
FL (SA)	12.46	12.56	12.45	12.55	1.99	-2.20	2.03	-2.21
FL (Gulf)	50.35	50.61	50.00	50.28	5.20	-5.92	5.30	-5.96
GA	0.74	0.74	0.73	0.73	0.29	-0.27	0.29	-0.27
LA	0.34	0.34	0.01	0.01	0.07	-0.07	0.07	-0.07
MS	0.72	0.75	0.72	0.75	0.29	-0.27	0.30	-0.28
NC	11.29	11.26	6.8	6.75	0.96	-1.11	0.97	-1.11
SC	4.44	4.46	4.31	4.33	0.76	-0.83	0.78	-0.85

Table 5-5. Nested Random Utility Models

	Full Choice Set		Restricted Choice Set	
	Model 1		Model 3	
Site Choice Variable	Coeff.	t-stat	Coeff.	t-stat
Travel Cost	-0.032	-11.66	-0.030	-10.61
Travel Time	-0.441	-11.76	-0.443	-11.37
Red Drum HCKR	0.867	11.00	0.882	11.00
Seatrout HCKR	0.159	6.00	0.158	5.96
Pelagic HCKR	1.973	8.55	1.949	8.45
Snapper-Grouper HCKR	0.725	3.44	0.769	3.43
Log(Sites)	0.532	13.15	0.531	13.11
Model Chi-Square: Site Choice	11,122		4169	
Choices (Sites)	141,712(68)		27,372 (13.09)	
Species Choice Variable	Coeff.	t-stat	Coeff.	t-stat
Inclusive Value	0.797	11.40	0.767	11.23
Model Chi-Square: Species Choice	146		139	
Choices	4		4	

Table 5-6. Nested RUM Estimates of Compensating Variation: Aggregate Values*

		Site Access (All Species) per:	
Site	Visits	Trip	Wave
Alabama	2.20	1.22	2.69
Florida (SA)	3.83	20.88	79.95
Florida (Gulf)	3.41	60.88	207.60
Georgia	3.24	1.22	3.96
Louisiana	2.96	19.87	58.87
Mississippi	3.59	1.70	6.10
North Carolina	3.28	12.87	42.23
South Carolina	3.57	9.01	32.15
		Species Access per:	
Species	Visits	Trip	Wave
Red Drum	3.39	10.53	35.73
Spotted Seatrout	3.53	8.07	28.48
Coastal Migratory Pelagic	3.22	9.21	29.65
Snapper-Grouper	3.06	9.38	28.72
		Unit Increase in Catch and Keep per:	
Species	Visits	Trip	Wave
Red Drum	3.39	10.08	34.19
Spotted Seatrout	3.53	1.20	4.22
Coastal Migratroy Pelagic	3.22	28.67	92.33
Snapper-Grouper	3.06	7.50	22.95

*Model 1: Full Choice Set, Mean Historic Catch

Table 5-7. NRUM Estimates of CV: Species Access by Site

Site	Visits	CV per Trip	CV per Wave
		Red Drum	
Alabama	1.83	0.17	0.31
Florida (SA)	4.73	1.28	6.07
Florida (Gulf)	3.25	3.14	10.23
Georgia	2.75	0.43	1.18
Louisiana	3.10	3.34	10.36
Mississippi	3.55	0.28	1.01
North Carolina	1.67	0.51	0.85
South Carolina	3.91	0.78	3.05
		Spotted Seatrout	
Alabama	2.29	0.09	0.21
Florida (SA)	4.98	1.32	6.56
Florida (Gulf)	3.72	3.01	11.19
Georgia	4.20	0.11	0.48
Louisiana	2.85	1.73	4.93
Mississippi	3.17	0.33	1.04
North Carolina	4.97	0.43	2.16
South Carolina	3.03	0.61	1.86
		Coastal Migratory Pelagic	
Alabama	2.14	0.25	0.54
Florida (SA)	3.42	2.16	7.39
Florida (Gulf)	3.10	3.48	10.80
Georgia	2.40	0.11	0.26
Louisiana	2.67	0.91	2.42
Mississippi	4.00	0.26	1.06
North Carolina	2.86	0.98	2.79
South Carolina	3.56	0.64	2.28
		Snapper-Grouper	
Alabama	2.50	0.25	0.62
Florida (SA)	3.10	1.60	4.97
Florida (Gulf)	3.29	4.44	14.58
Georgia	2.00	0.11	0.23
Louisiana	1.00	1.08	1.08
Mississippi	6.50	0.31	2.02
North Carolina	2.25	0.42	0.96
South Carolina	2.42	0.68	1.65

Table 5-8. NRUM Estimates of CV:
Unit Increase in Catch and Keep

Site	Visits	CV per Trip	CV per Wave
		Red Drum	
Alabama	1.83	0.22	0.40
Florida (SA)	4.73	1.50	7.10
Florida (Gulf)	3.25	3.43	11.17
Georgia	2.75	0.44	1.22
Louisiana	3.10	2.96	9.19
Mississippi	3.55	0.42	1.49
North Carolina	1.67	0.54	0.91
South Carolina	3.91	0.82	3.22
		Spotted Seatrout	
Alabama	2.29	0.02	0.04
Florida (SA)	4.98	0.21	1.04
Florida (Gulf)	3.72	0.46	1.72
Georgia	4.20	0.02	0.09
Louisiana	2.85	0.27	0.77
Mississippi	3.17	0.06	0.19
North Carolina	4.97	0.07	0.33
South Carolina	3.03	0.09	0.29
		Coastal Migratory Pelagic	
Alabama	2.14	1.01	2.16
Florida (SA)	3.42	6.52	22.27
Florida (Gulf)	3.10	11.89	36.92
Georgia	2.40	0.61	1.47
Louisiana	2.67	4.13	11.00
Mississippi	4.00	1.59	6.37
North Carolina	2.86	2.42	6.94
South Carolina	3.56	2.27	8.09
		Snapper-Grouper	
Alabama	2.50	0.23	0.58
Florida (SA)	3.10	1.41	4.38
Florida (Gulf)	3.29	3.52	11.56
Georgia	2.00	0.13	0.26
Louisiana	1.00	1.04	1.04
Mississippi	6.50	0.35	2.27
North Carolina	2.25	0.37	0.84
South Carolina	2.42	0.58	1.41

Table 6-1: Nested RUM Variable Descriptions and Means

Variable	Description	Mean
TCX	Trip Cost to Zone X	$332.31
TTX	Travel Time to Zone X (minutes): For Labor Market Corner Solutions	22.67
LNM	Log of Number of Sites in Zone X	2.67
MBIG	Square Root of Historic Catch Rate: Big Game Species	0.02
MSMALL	Square Root of Historic Catch Rate: Small Game Species	0.35
MBOTTOM	Square Root of Historic Catch Rate: Bottom Species	0.09
MFLAT	Square Root of Historic Catch Rate: Flat Species	0.01
MOTHER	Square Root of Historic Catch Rate: Other Species	0.10

Table 6-2: Nested RUM Parameter Estimates: Full Model

Variable	Description	Coefficient	t-stat
	Site Choice Model		
TCX	Trip Cost to Zone X	-0.015	20.6
TTX	Travel Time to Zone X (minutes)	-0.47	39.6
LNM	Log of Number of Sites in Zone X	0.77	35.2
MBIG	Square Root of Historic Catch Rate: Big Game Species	0.32	2.1
MSMALL	Square Root of Historic Catch Rate: Small Game Species	0.15	2.4
MBOTTOM	Square Root of Historic Catch Rate: Bottom Species	0.07	1.3
MFLAT	Square Root of Historic Catch Rate: Flat	0.49	2.9
MOTHER	Square Root of Historic Catch Rate: Other Species	-0.002	0.05
Model Chi-Square	All Parameters=0	7,413.59	
	Mode_Species Choice Model		
THETA_T	Inclusive Value: Targeted Species	0.53	4.4
THETA_NT	Inclusive Value: Non-Targeted	0.93	7.4
Model Chi-Square	All Parameters=0	1,467.77	

TABLE 6-3: The Mean Value of Access Per Trip by State and Wave

State	All Waves	Wave 2 March-April	Wave 3 May-June	Wave 4 July-Aug	Wave 5 Sept-Oct	Wave 6 Nov-Dec
North Carolina	$15.83	$8.08	$20.41	$15.81	$18.11	$14.16
South Carolina	$6.70	$6.60	$5.54	$6.48	$8.28	$6.61
Georgia	$2.58	$0.97	$3.75	$3.30	$2.51	$1.92
Florida (SA)	$12.01	$12.65	$10.36	$12.38	$11.27	$13.93
Florida (Gulf)	$45.88	$56.23	$44.11	$42.69	$43.65	$44.84
Florida (All)	$202.52	$237.35	$194.30	$202.04	$182.53	$206.54
Alabama	$1.56	$1.75	$1.88	$1.38	$1.24	$1.55
Mississippi	$3.63	$3.46	$3.46	$3.49	$4.03	$3.66
Louisiana	$11.68	$8.77	$11.77	$13.49	$11.70	$12.34
Gulf Coast	$82.22	$86.82	$79.29	$82.23	$82.72	$81.38
South Atlantic	$109.31	$75.82	$113.33	$109.04	$134.75	$103.82
Observations	6379	1039	1520	1115	1417	1288

Table 6-4: Willingness to Pay for a One Unit Fish Increase in Historic Catch and Keep Rates per trip

State	Big Game	Small Game	Bottom	Flat
North Carolina	$14.62	$6.63	$3.04	$22.68
South Carolina	$14.82	$6.77	$3.12	$22.96
Georgia	$14.44	$6.41	$2.98	$22.14
Florida (SA)	$14.63	$6.60	$3.01	$22.47
Florida (Gulf)	$15.02	$6.81	$3.09	$23.25
Alabama	$14.53	$6.54	$2.94	$22.27
Mississippi	$14.91	$6.70	$3.05	$23.02
Louisiana	$14.78	$6.58	$2.98	$22.93
All States	$14.83	$6.68	$3.04	$22.88

Table A1. Big Game Species

AFS COMMON NAME	MRFSS CODE
shark, blue	8708020601
tuna, skipjack	8850030101
albacore	8850030401
tuna, bigeye	8850030405
swordfish family	8850040000
swordfish family	8850040000
swordfish	8850040101
tarpon family	8738020000
tarpon, Atlantic	8738020201
hammerhead, smooth	8708030102
shark, white	8707040101
shark, tiger	8708020201
mako, shortfin	8707040501
hammerhead, great	8708030104
shark, thresher	8707040401
cobia	8835260101
cobia family	8835260000
dolphin family	8835290000
dolphin	8835290101
wahoo	8850030601
hammerhead shark family	8708030000

Table A2. Small Game Species

AFS Common Name	MRFSS Code
pompano, Florida	8835280901
dolphin, pompano	8835290102
seatrout, spotted	8835440102
seatrout, sand	8835440106
mackerel genus	8850030200
mackerel family	8850030000
mackerel, chub	8850030301
mackerel, Atlantic	8850030302
mackerel, Spanish	8850030502
mackerel genus	8850030700
mackerel, frigate	8850030702
jack family	8835280000
amberjack, greater	8835280801
lookdown	8835280701
leatherjacket	8835280501
jack, bluntnose	8835281401
jack, cottonmouth	8835281701
jack genus	8835280300
pompano, Irish	8835390201
shad, American	8747010101
shad, Hickory	8747010103
shad, Alabama	8747010104
shad, gizzard	8747010501
shad, threadfin	8747010502
snook family	8835010000
snook, common	8835010105
bonefish family	8739010000
bonefish family	8739010101
barracuda family	8837010000
barracuda, great	8837010104
tarpon family	8738010000
ladyfish	8738010101
bluefish genus	8835250100
bluefish genus	8835250101
bass, stripped	8835020102
mackeral, king	8850030501
drum, red	8835440901

Table A3. Bottom Fish Species

AFS Common Name	MRFSS Code
dogfish shark family	8710010000
lamniform shark families	8708000000
cat shark family	8708010000
sand tiger family	8707030000
tiger, sand	8707030101
dogfish, smooth	8708020401
dogfish, spiny	8710010201
carp, common	8776010101
catfish order	8777000000
catfish, hardhead	8777180202
toadfish, oyster	8783010201
toadfish, leapard	8783010203
codlet family	8791020000
cod, Greenland	8791030403
hake, southern	8791031007
haddock	8791031301
searobin family	8826020000
perciform families	8835020000
perch, white	8835020101
bass, white	8835020104
sea bass, rock	8835020305
croaker, blue	8835440304
spot	8835440401
croaker, Atlantic	8835440702
drum, star	8835441001
croaker, reef	8835441301
tautog	8839010101
unidenified (bottom fish)	1000000001
sawfish family	8713010000
sawfish, largetooth	8713010102
grunt family	8835400000
pigfish	8835400201
grunt, bluestriped	8835400113
sailors choice	8835400117
grunt, barred	8835400401
grunt, burro	8835400502
kingfish, southern	8835440601

Table A3. Bottom Fish Species (Cont.)

AFS Common Name	MRFSS Code
kingfish, northern	8835440603
mullet family	8836010000
mullet, redeye	8836010103
mullet, fantail	8836010105
cunner	8839010201
butterfish genera	8851030000
butterfish	8851030103
butterfish, gulf	8851030104
shark, nurse	8707020101
shark, bull	8708020502
grunt family	8835400000
pigfish	8835400201
grunt, barred	8835400401
grunt, burro	8835400502
porgy family	8835430000
porgy, longspine	8835430102
porgy, silver	8835430402
porgy, red	8835430602
scup	8835430101
sheepshead	8835430301
pinfish	8835430201
pinfish, spottail	8835430401
snapper family	8835360000
snapper, silk	8835360113
snapper, queen	8835360301
drum, spotted	8835441205
perch, white	8835020101
perch, yellow	8835200201
perch, sand	8835021002
snapper, yellowtail	8835360401
snapper, vermilion	8835360501
perch, silver	8835440301
drum, black	8835440801
jewfish	8835020401
grouper, yellowedge	8835020405
jewfish	8835020401
grouper, Nassau	8835020412
grouper, tiger	8835020550
grouper, marbled	8835020901

Table A4. Flat Fish Species

AFS Common Name	MRFSS Code
lefteye flounder family	8857030000
flounder, Gulf Stream	8857030104
flounder, fringed	8857030201
lefteye flounder genus	8857030300
flounder, gulf	8857030302
flounder, eyed	8857030603
sole family	8858010000
sole, scrawled	8858010201
flounder, summer	8857030301

Table A5. Other Species

AFS Common Name	MRFSS Code
herring family	8747010000
herring, blueback	8747010102
menhaden, Atlantic	8747010401
herring, Atlantic thread	8747010701
herring, Atlantic	8747010201
alewife	8747010105
eel, American	8741010101
conger eel family	8741120000
conger, eel	8741120101
snake eel family	8741130000
skate family	8713040000
stingray, bluntnose	8713050106
ray, spinny butterfly	8713050201
puffer genus	8861010200
puffer, bandtail	8861010211
puffer family	8861010000
puffer, smooth	8861010101
requiem shark family	8708020000
shark, Atlantic sharpnose	8708020301
shark, dusky	8708020501
shark, bull	8708020502
shark, smalltail	8708020512
shark, lemon	8708020801
shark, finetooth	8708021001

Table A6. Coastal Migratory Pelagic Fish

Species	MRFSS Code
Bluefish (Gulf only)	8835250101
Cobia	8835260101
Dolphin	8835290101
King mackerel	8850030501
Spanish mackerel	8850030502
Cero	8850030503
Little tunny	8850030102

Table A7. Snapper-Grouper

Species	MRFSS Code	South Atlantic	Gulf of Mexico
black sea bass	8835020301	*	
bank sea bass	8835020304	*	
rock sea bass	8835020305	*	
sand perch	8835021002		*
dwarf sand perch	8835021005		*
Jewfish	8835020401	*	*
rock hind	8835020402	*	*
speckled hind	8835020404	*	*
yellowedge grouper	8835020405	*	*
red hind	8835020406	*	*
red grouper	8835020408	*	*
misty grouper	8835020409	*	*
warsaw grouper	8835020410	*	*
snowy grouper	8835020411	*	*
Nassau grouper	8835020412	*	*
coney	8835020802	*	
Graysby	8835020801	*	
Gag	8835020501	*	*
black grouper	8835020502	*	*
yellowmouth grouper	8835020504	*	*
Scamp	8835020505	*	*
yellowfin grouper	8835020506	*	*
tiger grouper	8835020550	*	
Wreckfish	8835022801	*	
blackline tilefish	8835220102		*
Tilefish	8835220201		*
sand tilefish	8835220301	*	
yellow jack	8825280301	*	
crevalle jack	8835280303	*	
blue runner	8835280306	*	
greater amberjack	8835280101	*	*
lesser amberjack	8835280102	*	*
banded rudderfish	8835280104	*	*
black snapper	8835360201	*	
queen snapper	8835360301	*	*
cubera snapper	8835360101	*	*
gray snapper	8835360102	*	*
mutton snapper	8835360103	*	*

Table A7. Snapper-Grouper (Cont.)

Species	MRFSS Code	South Atlantic	Gulf of Mexico
schoolmaster	8835360104	*	*
blackfin snapper	8835360106	*	*
red snapper	8835360107	*	*
dog snapper	8835360109	*	*
mohogany snapper	8835360110	*	*
lane snapper	8835360112	*	*
silk snapper	8835360113	*	*
yellowtail snapper	8835360401	*	*
wenchman	8835360701		*
vermilion snapper	8835360501	*	*
black margate	8835400304	*	
porkfish	8835400306	*	
tomtate	8835400101	*	
white grunt	8835400102	*	
margate	8835400103	*	
smallmouth grunt	8835400107	*	
French grunt	8835400108	*	
Spanish grunt	8835400110	*	
cottonwick	8835400111	*	
bluestriped grunt	8835400113	*	
sailors choice	8835400117	*	
sheepshead	8835430301	*	
grass porgy	8835430501	*	
jolthead porgy	8835430502	*	
saucereye porgy	8835430503	*	
whitebone porgy	8835430505	*	
knobbed porgy	8835430506	*	
red porgy	8835430602	*	
scup	8835430101	*	
longspine porgy	8835430102	*	
Atlantic spadefish	8835520101	*	
puddingwife	8839010709	*	
hogfish	8839010901	*	*
gray triggerfish	8860020202	*	*
queen triggerfish	8860020201	*	*
ocean triggerfish	8860020502	*	
bar jack	8835280308	*	
almaco jack	8835280803	*	*
blueline tilefish	8835220104	*	

Table A7. Snapper-Grouper (Cont.)

Species	MRFSS Code	South Atlantic	Gulf of Mexico
goldface tilefish	8835220105		*
anchor tilefish	8835220103		*

Table A8. County Zone Codes

State	COUNTY	SUB_REG*	COUNTY	ZONE2	ZONE3
Alabama	BALDWIN	7	3	1	1
Alabama	MOBILE	7	97	2	2
Florida	BAY	7	5	3	3
Florida	BREVARD	6	9	4	4
Florida	BROWARD	6	11	5	5
Florida	CHARLOTTE	7	15	6	6
Florida	CITRUS	7	17	7	7
Florida	COLLIER	7	21	8	8
Florida	DADE	6	25	9	9
Florida	DIXIE	7	29	10	10
Florida	DUVAL	6	31	11	11
Florida	ESCAMBIA	7	33	12	12
Florida	FLAGLER	6	35	13	
Florida	FRANKLIN	7	37	14	13
Florida	GULF	7	45	15	14
Florida	HERNANDO	7	53	16	15
Florida	HILLSBOROUGH	7	57	17	16
Florida	INDIAN RIVER	6	61	18	17
Florida	LEE	7	71	19	18
Florida	LEVY	7	75	20	19
Florida	MANATEE	7	81	21	20
Florida	MARTIN	6	85	22	21
Florida	MONROE	7	87	23	22
Florida	NASSAU	6	89	24	23
Florida	OKALOOSA	7	91	25	24
Florida	PALM BEACH	6	99	26	25
Florida	PASCO	7	101	27	26
Florida	PINELLAS	7	103	28	27
Florida	ST JOHNS	6	109	29	28
Florida	ST LUCIE	6	111	30	29
Florida	SANTA ROSA	7	113	31	30
Florida	SARASOTA	7	115	32	31
Florida	TAYLOR	7	123	33	32
Florida	VOLUSIA	6	127	34	33
Florida	WAKULLA	7	129	35	34
Florida	WALTON	7	131	36	35
Georgia	BRYAN	6	29	37	36
Georgia	CAMDEN	6	39	38	37

Table A8. County Zone Codes (Cont.)

State	COUNTY	SUB_REG*	COUNTY	ZONE2	ZONE3
Georgia	CHATHAM	6	51	39	38
Georgia	GLYNN	6	127	40	39
Georgia	LIBERTY	6	179	41	40
Georgia	MCINTOSH	6	191	42	41
Louisiana	CALCASIEU	7	194342		
Louisiana	CAMERON	7	23	44	43
Louisiana	IBERIA	7	45	45	
Louisiana	JEFFERSON	7	51	46	44
Louisiana	LAFOURCHE	7	57	47	45
Louisiana	ORLEANS	7	71	48	46
Louisiana	PLAQUEMINES	7	75	49	47
Louisiana	ST BERNARD	7	87	50	48
Louisiana	ST MARY	7	101	51	49
Louisiana	TAMMANY	7	103	52	50
Louisiana	TANGIPAHOA	7	105	53	
Louisiana	TERREBONNE	7	109	54	51
Louisiana	VERMILLION	7	113	55	52
Mississippi	HANCOCK	7	45	56	53
Mississippi	HARRISON	7	47	57	54
Mississippi	JACKSON	7	59	58	55
North Carolina	BEAUFORT	6	13	59	56
North Carolina	BRUNSWICK	6	19	60	57
North Carolina	CARTERET	6	31	61	58
North Carolina	CRAVEN	6	49	62	
North Carolina	CURRITUCK	6	53	63	
North Carolina	DARE	6	55	64	59
North Carolina	HYDE	6	95	65	60
North Carolina	NEW HANOVER	6	129	66	61
North Carolina	ONSLOW	6	133	67	62
North Carolina	PAMILICO	6	137	68	63
North Carolina	PENDER	6	141	69	64
North Carolina	TYRRELL	6	177	70	
South Carolina	BEAUFORT	6	13	71	65
South Carolina	BERKELEY	6	15	72	66
South Carolina	CHARLESTON	6	19	73	67
South Carolina	COLLETON	6	29	74	68
South Carolina	GEORGETOWN	6	43	75	69
South Carolina	HORRY	6	51	76	70
South Carolina	JASPER	6	53	77	

Appendix B
SAS Program and Data Documentation

This appendix attempts to guide the user through the SAS programs and data developed for the SE MRFSS-AMES project. The SAS programs and MRFSS-AMES Data are located in the level 5 directories:

C:\My Documents\research\nmfs\sas\data\
C:\My Documents\research\nmfs\sas\species\

Therefore, each of these programs adopts these directory names. The user may wish to create these directories on his/her own computer in order to avoid renaming directories in numerous SAS files. Users of these programs should also reference the Areadme@ files contained in each folder. Begin with the only file in the SAS directory:

C:\My Documents\research\nmfs\sas\Readme.txt

This 'readme' files, in general, briefly describes the contents of the data and SAS program files and directs the user to the next step of the analysis. These files are summarized and further explained in the sections below.

Data

The raw data can be downloaded from the NMFS anonymous FTP server:

ftp://ftp.ssp.nmfs.gov/mrfss/

The AMES data was obtained from the southeast NMFS office. The following level 6 folders can be found in level 5 'data' folder.

Directory	Contains
\Ames	1997 AMES intercept and telephone data; distance data created externally by PC*Miler
\Type1	Type 1 MRFSS data for 1992-1997 (Waves 2-6)
\Type23	Type 2 and 3 MRFSS data for 1992-1997 (Waves 2-6)

The SAS programs require that the SAS data sets obtained from the NMFS be put into these directories. Otherwise, the user will be renaming numerous SAS libname, etc. lines of code.

SAS Programs

The following level 6 folders can be found in the level 5 'species' folder:

Directory	Purpose
\kingmack	Contains coastal migratory pelagic programs and data

\nested	Estimates the nested logit models from Chapter 5 (run these programs after the programs in the four species directories are run)
\reddrum	Contains red drum programs and data
\redsnap	Contains snapper-grouper programs and data
\weakfish	Contains spotted seatrout programs and data
\welfare	Estimates welfare with nested RUM models (run these programs after the nested programs are run)

The species (kingmack, reddrum, redsnap, and weakfish) folders need to be attacked first but in any order. Then go to the 'nested' and 'welfare' folders in that order.

The following level 7 folders can be found in the kingmack, reddrum, redsnap, and weakfish directories:

Directory	Purpose
\Ames	Merge the 97 MRFSS with 97 AMES
\Catch	Create 5 year average catch with 92-96 MRFSS
\Intercept	Merge the 97 MRFSS type 1, 2, and 3 data
\Rum	Develop data and estimates NRUMs
\Welfare	Estimates welfare with RUM models

The level 7 folders must be entered in the following order: 'intercept,' 'catch,' 'ames,' 'rum' and 'welfare.' A numbered (in order) 'readme' file can be found in each folder. In each folder, read the readme#.txt file and follow the directions. An intermediate data directory must be created manually in each level 7 folder: \ames\adata\, \catch\data\, \intercept\idata\, \rum\rumdata\, and \welfare\wdata\. Note that four of the five intermediate data folders are called x_data where the x_ is filled in with the first letter of the level 7 folder name. The exception is \catch\data\ which does not have an additional letter.

The following five sections of this appendix describe the programs to be run in the 'kingmack,' 'reddrum,' 'redsnap,' and 'weakfish' directories. After the user completes running these programs, run the programs in the level 6 'nested' folder (detailed as #6 below) and the level 6 'welfare' folder (#7 below). Run all programs in the order indicated in brackets [#] of the program name. Changes that need to be made to each program to run species specific models are mentioned below and commented out (e.g. /* Achange something here@ */) in the SAS program.

For the four species (groups) nested model there are 184 SAS programs (166 =156 data/rum [39*4 species] + 10 nested + 18 welfare) SAS programs. Some users may find it easier to run the programs separately. Others may find this to be too mind numbing. In this case, of course, the programs can be edited to create larger programs. The large program approach is the one we took to estimate the nested logit model presented in

Chapter 6. The programs for the Chapter 6 models follow the same basic approach described below and can be found in the level 5 directory:

C:\my documents\research\nmfs\sas\ch6\

1. Intercept Data Programs

The three programs in the level 7 ‘intercept’ folder create the 1997 MRFSS intercept data.

The 'Type1_97 [1].sas' program is designed to select species for estimation, re-code and labels the MRFSS intercept data, creates county level destinations (zones), and punches out the SAS data set \idata\i97.sd2. The species code(s) needs to be changed once in this program to adapt it for other species. Note that the data is stored in the intermediate data directory: \intercept\idata\.

The 'Type23_97 [2].sas' program selects the southeastern states for estimation, selects species of interest, merges Type 1, 2 and 3 data, and punches out the SAS data set \idata\catch97.sd2. The species code(s) needs to be changed three times in this program.

The 'Merge type1 and type23 [3].sas' program merges Type 1 and Type 2, 3 files for 1997 and punches out the SAS data set \idata\merged97.sd2.

2. Catch Data Programs

The purpose of the seventeen programs in the level 7 ‘catch’ folder is to create 5 year average catch rates for the 1992-1996 MRFSS data. Run these programs in the order indicated in brackets [#]. Again, changes that need to be made to each program to run species specific models are stated.

There are five 'Type1_9x [#].sas' (where x = 2-6 and # = 1-5) programs. The purpose of these programs is to select species, re-code and label intercept data, and create county level destinations. These programs are identical to the 1997 Type 1 programs in the ‘intercept’ folder except for the year. The species code(s) needs to be changed once in each program.

There are also five 'Type23_92 [#].sas' (where x = 2-6; # = 7-11) programs. The purpose of these programs is to selects southeastern states, select species of interest, merge Type 1, 2 and 3 data, and punch out the SAS data set \data\catch9x.sd2. Note that the data is stored in the intermediate data directory \catch\data\. These programs are identical to the 1997 Type 2 and 3 programs in the ‘intercept’ folder except for year. The species code(s) needs to be changed three times in each program to adapt them to different species.

The purpose of the 'Merge type1 and type23 [11].sas' is to merge Type 1 and Type2, 3 files for 1992-96, and create the SAS data set \catch\data\merged9x.sd2.

The purpose of the five programs named 'hcr9x [#].sas' (where x = 2-6; # = 12-16) is to define the county level zone variable (zone2 = 1-77), county level catch rate variables, and create the SAS data set \catch\data\hcr9x.sd2. These data contain the historic catch rates.

The purpose of the program 'Create mean hcr [17].sas' is to create mean catch and keep rates by wave (2-6), site (zone2=1-76), and mode (1-3) for the 1992-1996 MRFSS. The program punches out the SAS data set \ames\adata\hcr92_96.sd2. Note that this is placed in the new intermediate data folder \ames\adata\.

3. Ames Data Programs

The purpose of the five programs in the level 7 ‘ames’ folder is to create the 1997 MRFSS-AMES data.

The first SAS program is 'Add-ames [1].sas'. The purpose of this program is to re-code variables, merge add-on (the add-on intercept survey contains expenditures data) and AMES (telephone) data, re-code variables from the add-on intercept survey, and punch out the SAS data set \adata\add_ames.sd2. Note that the data is stored in the intermediate data folder \ames\adata\.

The purpose of the second SAS program, 'Merge MRFSS and ADD_AMES data [2].sas', is to merge the MRFSS Type 1, 2, and 3 intercept data with the merged add-on-AMES data, recode some more variables, and punch out the SAS data set \adata\mr_ames1.sd2.

The purpose of the SAS program 'Merge distances and impute income [3].sas' is to merge county level distance data (calculated with PCMiler externally), impute missing income values, and punch out the SAS data set \adata\mr_ames2.sd2.

The purpose of the next SAS program, 'merge with hcr [4].sas', is to create the county level site variable (zone2=1-77) for 1997 data, merge in \adata\hcr92-96 by wave, mode, and zone2, and punch out the SAS data set \adata\mr_ames3.sd2.

The last program in this directory, 'Create RUM1 data [5].sas', renames distance data to county level zone codes, recodes and cleans some more variables, and punches out the SAS data set \rdata\rum1.sd2. Note that the data is stored in a new intermediate data folder \rum\rdata\.

4. Programs to Run Non-Nested RUMs

The nine programs in ‘rum’ folder estimate Poisson household production models and conditional logit site choice models. There are ten programs in this directory, nine of which are required for estimation.

The first thing that must be done is to find out which zones are not represented in the catch data. The purpose of the SAS program 'check for missing zone2 [0].sas' is to check for missing values in the hcr92_96 historical catch (by wave/zone2/mode) data. The output will be a frequency table with the zones that are represented in the catch data for the species (group) of interest. Any missing zones must be entered manually in the next program.

The purpose of the SAS program 'create obs for missing sites [1].sas' is to impute zero values for missing catch rate data. After checking to see if there are any missing zone2s in the table from the previous SAS program, for each missing zone2 (1-76) add lines to the temp data ‘addzone2.’ In the data entries make sure mcatch=mharv=0. It does not matter the values that wave and mode take. For example, with red drum no one visited zone2 = 36, 37, 63, 70. So the following data must be entered:

```
data addzone2;
input zone2 wave mode mcatch mharv;
cards;
36 2 1 0 0
37 2 1 0 0
63 2 1 0 0
70 2 1 0 0
;
```

This program creates observations for missing values in the hcr92_96 catch rate data and punches out the SAS data set: \catch\data\missing1.sd2.

The purpose of the SAS program 'create transposed catch rates [2].sas' is to merge the SAS data set \adata\hcr92_96.sd2 with \catch\data\missing1.sd2, create the catch rate at site=x variables (mharv1-mharv76) by mode, wave, and save the transposed catch data as the SAS data set \ames\adata\transcrt.sd2

The third program, 'Define variables [3].sas', defines 76 site indicator variables (ind1-ind76), computes 76 travel cost variables (travc1-travc76), defines 1 site indicator variable (yx = 1-76), defines 76 distance variables, and punches out the intermediate data SAS set: \rdata\rum2.sd2. Note that this data set is stored in the new intermediate data folder \rum\rdata\.

The purpose of the SAS program 'Expected catch [4].sas' is to merge historic catch and keep rates with the AMES data, create expected catch and keep variables (eharv1-eharv76), and punch out the SAS data set \rdata\rum3.sd2. The Poisson model is estimated with PROC GENMOD. This program also prints output for the Poisson household production model. Note that if the model is misspecified for an alternative species (group), and different specifications are estimated in PROC GENMOD, then several lines in the middle of the program (naming the variables in Poisson model) must be changed to accommodate the alternative model.

Next, the distance based choice sets are defined with the SAS program 'Define choice sets [5].sas'. This program defines choice set 1 (deleting all sites where none visited), defines choice set 2 (deletes sites > 180 miles away), continues to create preliminary data for the RUM, and punches out the SAS data set \rdata\rum4.sd2.

The purpose of the program 'transpose data for RUM [6].sas' is to transpose all of the ‘1-76’ variables for the random utility model, and punches out data for RUM estimation \rdata\rum5.sd2.

The two programs 'PHREG with choice set i [z].sas' (i = 1, 2; z = 7,8) runs conditional logit models (site-selection RUMs) with mean historic and predicted catch and keep rate variables and outputs choice set i RUM results (as SAS data sets \rdata\betas1.sd2, \rdata\betas2.sd2). The RUMs are estimated with PROC PHREG.

The program 'participation model [9].sas' can be skipped. It’s purpose is to estimate four participation models, calculate four site-selection level inclusive values (iv1 = choice set 1, mean historic catch, iv2 = choice set 1, expected catch, iv3 = choice set 2, mean historic catch, iv4 = choice set 2, expected catch) and punch out logistic coefficients (part1-part4) to \rdata\partx.sd2 (where x = 1-4). It estimates the participation models with PROC LOGISTIC. Early versions of the resulting nested RUMs for the participation-site choice did not perform well with coefficients on the inclusive values being statistically insignificant. However, some recent adjustments lead to successful estimation of the nested participation/site choice model for coastal migratory pelagic (inclusive value coefficient estimate = .11), red drum (inclusive value coefficient estimate = .23-.45), and spotted seatrout (inclusive value coefficient estimate = .10-.23). Future welfare estimation with these models may prove fruitful.

5. Programs to Calculate Welfare Estimates from RUM

The six programs in the ‘welfare’ folder estimate compensating variation of site access and catch rate improvements for four models.

The first program is optional. The purpose of 'quick welfare [0].sas' program is to compute 'quick and dirty' (see Chapter 4 Appendix) welfare estimates with model 1. The estimates are the compensating variation of one more fish at all sites and the compensating variation per trip.

The purpose of the program 'create data [1].sas' is to merge the nested model (participation/site choice) data with \rdata\inclusiv.sd2 and punch out the SAS data set \welfare\wdata\welfare1.sd2. Note that the nested component of the welfare calculations is not included in the following four programs.

The four programs 'model i [i+1].sas' (where i = 1-4) computes RUM welfare estimates for model 1 (choice set 1, mean historic catch and keep), model 2 (choice set 1, predicted catch and keep), model 3 (choice set 2, mean historic catch and keep), and model 4 (choice set 2, predicted catch and keep). The estimates provided are the compensating variation (CV) per trip by state and the CV per (1 more) fish by state. All of these estimates are further broken down by wave.

6. Nested Logit Programs

The purpose of the eleven programs in the Level 6 ‘nested’ folder is to create inclusive values for each of the branches in the nested model and estimate the species choice model. Ten of the programs must be run. The last program included is a failed attempt to model and higher level nested model with participation in the boat mode/species (groups) categories.

The purpose of the program 'no harvest IV [0].sas' is to create a temporary variable for missing harvest data. It creates the SAS data set \ndata\noharv.sd2. Note that this is stored in the \nested\ndata\ intermediate data folder. This program cleans out observations that are not targeting one of the four species (groups).

The purpose of the program 'Stack RUM data [1].sas' is to stack RUM data and define independent variables for the four targeted mean historic catch and keep rates. This program also defines the dependent variable (target) for the species choice model.

There are two programs which run the nested logit site choice models: 'PHREG with choice set i [i+1].sas' (where i = 1,2). The purpose of these programs is to run site-selection RUMs with the mean historic catch rate variable and outputs choice set i RUM results (SAS data sets betas1.sd2, betas2.sd2) to \nested\ndata\.

The next four programs calculate the site selection level inclusive values. The programs are named: 'x_fish IV [j].sas' (where x_ = weak, red, cmp, and reef and j = 1-4) Each program calculates two species-selection level inclusive values: iv1 (choice set 1, mean historic catch and keep rate) and iv2 (choice set 2, mean historic catch and keep rate).

The purpose of the program 'species choice [9].sas' is to stack the species choice data and run two species choice (4 choices) models with the independent variables iv1 and iv2.

The last program in this directory is: 'mode-species choice [10].sas'. This program stacks species choice data and attempts to run two boat-mode/four-species-choice participation models. These models produce estimates of sigma outside the 0,1 interval.

7. Programs to Calculate Welfare Estimates from RUM

The purpose of the eighteen programs in the Level 6 ‘welfare’ folder is to estimate compensating variation values from the nested logit model. The first two programs are necessary for the welfare estimation. The next 16 programs are some of the welfare estimates than can be produced with this model. However, some of the choice set 2 programs do not work properly (producing negative estimates of CV for some cases).

The first required program is: 'set data for welfare [0].sas'. This program stacks 'rum4' data for the four species groups, deletes those with missing harvest data and those who don't target species (groups) 1-4, brings in the 'betas' and 'alphas' data from the site and species choice models, merges in ‘transcrt’ catch rate data for each species (groups), and merges the individual/coefficient data and catch rate data. The resulting SAS data set is \wdata\welfare.sd2. Note that this is stored in the intermediate data folder '\welfare\wdata\.'

The second required program is 'base case utility [1].sas'. This program defines the base case utilities for the four species groups and two choice sets.

The next eight programs estimate the compensating variation for site elimination and catch and keep rates improvement and summarize these estimates by state and by state-wave for choice sets 1 and 2. The programs are called: 'X sites, set i [i+1].sas' (where X = weakfish, red drum, cmp, and reef; i = 1,2).

The purpose of the SAS programs 'all sites, set i [10].sas' (where i = 1, 2) is to estimate compensating variation for site elimination for all species and summarize these estimates by state and by state-wave for choice sets 1 and 2.

The purpose of the program 'species, sets 1 and 2 [12].sas' is to calculate (for choice sets 1 and 2) compensating variation for loss of species per trip occasion, average number of targeted trips across wave, and compensating variation for loss of species by wave.

The purpose of the program 'CV per fish, sets 1 and 2 [13].sas' is to estimate the compensating variation of increased catch at all sites in the southeast MRFSS.

The next four programs estimate the compensating variation of increased catch at all sites within each state. The programs are called 'CV per fish, x by state [14].sas' (where x = weakfish, red drum, cmp and reef).